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LIBERAL EDUCATION OF THE NINETEENTH CENTURY.[1]

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THE collapse of that classical system of liberal education which has held almost undisputed sway since the revival of learning in the sixteenth century, and the now generally recognized insufficiency of the theory which makes the study of the languages of Greece and Rome the sole foundation of the higher education, are leading, as all familiar with the educational thought of the present day are aware, to the greatest variety of speculations as to the system which is destined to supersede it. That a theory of liberal education as well adapted to the wants of the nineteenth—or, shall we not rather say the twentieth—century, as was the classical theory to the wants of the sixteenth, has yet been elaborated, would be quite too much to affirm. We are living in the midst of a chaos of conflicting opinions, and it seems to be the duty of all who think at all on a subject on which the vital interests of the future so much depend, and especially incumbent on all practical teachers to make such contribution as they are able, from their studies and reflection or their experience, toward the right solution of the problem. It is to such a contribution that I now ask your attention.

I begin with a definition of Liberal Education, in regard to which I presume we shall not be much at variance. The term liberal is opposed to the term servile. A liberal education is that education which makes a man an intellectual freeman, as opposed to that which makes a man a tool, an instrument for the accomplishment of some ulterior aim or object. The aim of the liberal education of any period is the right use of the realized capital of extant knowledge of that period, for the training of the whole, or only of some privileged part of the

[1] A paper read in the Department of Higher Instruction at the annual meeting of the National Teachers' Association at Elmira, N. Y., August, 1873.

rising generation, to act the part and perform the duties of free, intellectual, and moral beings. So far as the nature of the human mind and the foundations of human knowledge remain the same from age to age and generation to generation, a liberal education is the same thing in every age and generation; so far as the condition of society varies from age to age, and as the accumulated capital of extant knowledge increases, the liberal education of one generation will differ from that of another. There are, therefore, both constant and variable factors in our problem. It is with the variable factors, as modifying our conception of the liberal education of the nineteenth century, that I have here chiefly to do.

I reckon five leading influences which are acting powerfully to modify all our old theories, and slowly working out a new ideal of liberal education: 1. A truer psychology, giving us for the first time a true theory of elementary teaching. 2. Progress in the science of philology, enabling us to assign their right position to the classical languages as elements in liberal culture, and giving us, in modern philological science, an improved and more powerful teaching instrument. 3. The first real attempt to combine republican ideas with the theory of liberal education—in other words, to make the education of the whole people liberal, instead of merely the education of certain privileged classes and protected professions. And when I say the whole people, I mean *men and women*. Nothing, I will say in passing, to my mind so marks us as still educational barbarians, so stamps all our boasted culture with illiberality, as an exclusion of the other sex from all share in its privileges. No education can be truly liberal which is not equally applicable to one sex as to the other. 4. As the influence more profoundly modifying our conceptions of liberal education than any other, I reckon the advent of modern physical science. 5. I count among those influences the growing perception that art and æsthetic culture are equally necessary as an element in all education worthy of the name. Let me give the few words, which are all the time will allow me, to each of these influences.

And, first, the advance we have been making toward a truer education-philosophy, based upon truer conceptions in regard to the growth and early development of the human mind, is pretty well disposing of what, perhaps, I may be permitted to call the old-fashioned grindstone-theory of elementary education; the doctrine, namely, that, as preparation for higher culture, all youthful minds require a certain preliminary process of sharpening upon certain studies, valueless or next to valueless in themselves, at least so far as regards the vast majority of their recipients, but quite as needful, nevertheless, to them as to all others who are hereafter to be considered as liberally educated, for the indirect benefit their pursuit was supposed to confer. The accepted theory of liberal education has heretofore been, that it was a certain very special kind of training which required this peculiar pre-

liminary sharpening process, and that, as the instruments for it, there were certain almost divinely-appointed studies exclusively set apart, to wit, the grammars of two dead languages, and the elementary portions of abstract mathematics. It was not and could not be maintained that these studies would ever be the natural choice of the youthful mind in the beginning of its scholastic career; rather, it was thought to be a prime recommendation that they were as remote as possible from any thing the youthful mind would of itself appropriate as intellectual nutriment. Like medicine, the value of such disciplinary studies was supposed to be in direct proportion to their disgustfulness; for they were not food to nourish the mind withal, but tonics, wherewith artificially to strengthen it. They were rods for the spiritual part, the counterparts of those material ones which the strong right arm of the ancient pedagogue wielded with such efficiency on the bodies of his youthful charge, and the benefit of both alike was not utilitarian, but disciplinary.

That I may not be suspected of caricaturing, I will make two quotations, the first from a lecture by Prof. Sellar, Professor of Greek in the University of Edinburgh: "The one extreme theory," he says,[1] "is that education is purely a discipline of the understanding; that the form of the subject is every thing, the content little or nothing. A severe study, such as classics or mathematics, is the thing wanted to train or brace the faculties; it does not matter whether it is in itself interesting or not. The student will find sufficient interest in the sense of power which he has to put forth in training for the great race with his competitors. 'It is not knowledge,' they say, 'but the exercise you are forced to incur in acquiring knowledge that we care about. Read and learn the classics simply for the discipline they afford to the understanding. You may, if it comes in your way and does not interfere with your training, combine a literary pleasure with this mode of study, but this is no part of your education. As teachers, we do not care to encourage it; we do not care to interpret for you the thought or feeling of your author. All such teaching is weak and rhetorical: we do not profess to examine into your capacity of receiving pleasure. Accurate and accomplished translation, effective composition in the style of the ancient authors, thorough grammatical and philological knowledge—these are our requirements. The training in exactness, in concentration, in logical habits, and in discernment of the niceties of expression, is the one thing with which we start you in life. Whether you have thought at all, or care to think about the questions which occupy and move the highest minds, is no affair of ours.'

"This theory is, I think, a purely English theory of education. It has grown up within the last half-century, and it is in the University of Cambridge that it has been, and still is, most fully realized."

My other extract shall be from an essay by the Public Orator of the

[1] "Theories of Classical Teaching: A Lecture," p. 10.

University of Cambridge: "I conclude, then," says Mr. W. G. Clark, "that the first subject of study must be the same for all, and that it is no valid objection to any subject to affirm that it is dry and distasteful, but, on the contrary, a strong recommendation. It cannot be denied that this condition is amply satisfied by the Latin accidence, as exhibited in our time-honored and much-abused text-books. . . . The question arises where, besides the Latin grammar, we can find any other subject equally dry, and by consequence as powerfully tonic to the juvenile mind, which recommends itself as deserving in lieu thereof to form the basis of education by its general applicability and greater fertility of after-results. Except the Greek language, which, from its intimate connection with the Latin in structure and literature, is a necessary complement to it, and not a possible substitute for it, I know of none."

Here we have the very essence of what I have denominated the grindstone-theory. I think that a truer philosophy has exploded these fallacies, and wellnigh obliterated that artificial line of distinction between studies for use and studies for discipline. True education remains and must remain forever a discipline; but juster views in regard to the nature of the youthful mind are beginning to show us that that discipline is of the nature of a nutritive rather than a curative process, and that the disgust felt by the recipient for the means employed is no measure of their disciplinary value. We are discovering that the idea of discipline inheres not in the nature of certain particular subjects, distinguishing them from all others which are non-disciplinary and merely utilitarian, but in the right method of teaching all subjects; and the question, whether at any particular period or stage of progress a subject is to be used for purposes of mental discipline, depends not at all upon the question whether it belongs to one or the other of two imaginary classes, the disciplinary and the non-disciplinary, but upon the quite different questions whether the study is valuable in itself, and whether it is suited to that particular stage of the pupil's mental progress. If so, and if rightly taught, it will then be sure to be the right discipline.

This change in our education-philosophy has brought with it a corresponding change in our scale and estimate of the relative value of various studies as the instruments and materials of education; and, I think, we have almost heard the last of the doctrine that abstract grammar and abstract mathematics are the divinely-appointed whetstones and sharpeners of the youthful mind, and hence of the system which makes a compulsory study of the Greek and Latin languages the only gate of admission to the privileges of the higher education. In place of that very simple but most unphilosophical doctrine, I trust that a truer psychology is providing us with a course of liberal study, based upon correcter notions in regard to the laws of mental develop-

[1] "Cambridge Essays," for 1855.

ment. That we have such a completed practical psychology, or any such logical and symmetrical course or courses of study based upon it, is more than can be asserted, for education, as a science, is still in its infancy; but we certainly have attained to certain general principles which are fundamental as regards the elementary education of the future; and the most important of these, which is even now revolutionizing all our methods of elementary teaching, is the direct result of the progress of modern physical science. It is, that education begins with the concrete, and not with the abstract, and that the right method for the teaching even of language itself is the right training and development of the child's senses. The Latin grammar, therefore, as the right instrument for training the youthful mind, is fast disappearing, along with that birch which was its material symbol and needful complement, and a *striking* witness to the absurdity of the use we put it to. *Requiescat in pace!* The lovers of the noble science of classical philology may well be congratulated on its emancipation from such degrading servitude.

In place of this rude and crude, and now happily obsolescent theory, a deeper philosophy is leading us to inquire into the nature of the undeveloped mind, and the true order of the development of its faculties, and is, at the same time, guiding us to the right choice of means for stimulating their natural and healthful growth and unfolding. And here I will say that the answer which psychology gives to these questions seems to me a little in danger of being misinterpreted for the time being by one class of educational reformers. In their reaction against the premature and unnatural stimulus given to the powers of abstraction by the old system, they are in danger of running into the opposite extreme of paying a too exclusive attention to the development of the observing powers in the new—a tendency which the influence of modern physical science on our educational ideas, especially, tends to foster. I doubt whether one extreme will prove any better than the other, for both are equally one-sided. The true lesson we are to learn is, above all things, to have regard to balance and proportion. The youthful mind is not a different thing from the same mind in its maturity. The germs of all faculties exist in it, and their development is in no linear order, but rather like rays diverging from one centre; and the true conception of the different stages of education is, as being divided by concentric circles, cutting those rays at equal distances from the centre. The child's observing powers should furnish him with intellectual material no faster than his powers of abstraction can work it up into intellectual products, or than the development of his powers of expression can give form to them. On the other hand, his powers of expression should never be developed in empty words, beyond the limits of his acquisition of the ideas words stand for, as is now the case with so much of our word-mongering education. Again, his imagination should never outrun his reason on the

one hand, nor his memory overload it on the other, in accordance with that preposterous doctrine we sometimes hear propounded, which advocates the employment of the youthful memory in laying up stores of unintelligible knowledge, in anticipation of an after-time, when it will become intelligible—as if there could be such a thing as not-understood knowledge, in any other sense than as we speak of undigested food—turning to poison in the system. The child is a philosopher, a moralist, a poet in little, quite as much as he is an observer or a rememberer, and his whole moral and intellectual growth will be warped and stunted so long as you insist upon looking on him as a mere observing or a mere memorizing machine, a mere receptacle for facts or for words either.

If I am right in this view of the true character of elementary education, it follows that the great departments, into which it should from the very first be divided, correspond exactly with the primary divisions of knowledge itself, as they will continue for the pupil forever after. Let me, for the purposes of this discussion, make a triple division of knowledge into physical, ethical, and æsthetical, according as our thought is concerned with the world of matter, the world of mind, and the world of art or beauty. I am concerned here less for strictness of philosophical accuracy than for the practical convenience of this division. Now, as, in accordance with our fundamental conception of liberal education, the question as to a choice between these departments of liberal learning is a futile one, because all are essential elements in our conception of liberal education—so, if I am right, no conception of elementary education can be a correct one that does not provide for them all from the very beginning.

I need hardly point out what a change in all our methods this change in our philosophy implies; for it involves the doctrine that the true place to begin the teaching of all art, all science, all knowledge, is the primary school; and I am not in the least afraid of the seeming paradox. Rather I would earnestly maintain that, unless we treat the child in the primary school as the germ and embryo of all he is destined afterward to become, our education will be doomed to ignominious failure. Whatever, therefore, enters into our conception of liberal education—and we have already seen that nothing less than all extant knowledge should enter into it—that should enter into it from the beginning. Language and literature should be the subjects of elementary teaching; science should be the subject of elementary teaching; art should be the subject of elementary teaching. Whatever is to enter into the higher stages of education is to have its seed planted there, or it never will be planted. The true distinction, therefore, between disciplinary and non-disciplinary, is not a distinction between one set of studies begun early and another set of studies begun late, one set of studies pursued for training, and another set of studies mastered for use: it is a distinction between the earlier and the later

stages of all studies whatever. The child, as well as the man, is linguist, student of science, artist, philosopher, moralist, poet, though his philology, science, art, philosophy, will be childish, not manly, germs and intuitions, not results of developed reason. Is it not obvious that in this view elementary schools become something far more than places for drilling the youthful mind in the use of the mere tools of knowledge? Is it not obvious, moreover, that, looked at from this point of view, a man's profession is only the outgrowth and fruitful consummation of his *whole* training; a divergence, when the time arrives that the whole of knowledge becomes too wide a field to cultivate, into some special fruit-bearing direction, which, whatever it may be, will lead to a truly liberal profession, inasmuch as by a man so trained his calling cannot but be followed in a liberal spirit?

We have in England and America no conception of what may be accomplished in the early stages of education, because we have been, to so great an extent, adherents of the grindstone-theory. "Nowhere," says Mr. Joseph Payne, commenting on the lamentable, almost ludicrous, failure of that embodiment of the grindstone-theory, applied to popular teaching through the medium, not of the Latin grammar, but of the three R's—I mean the so-called English "Revised Code"—"nowhere have I ever met, in the course of long practice and study in teaching, with a more striking illustration of the great truth that, just in proportion as you substitute mechanical routine for intelligent and sympathetic development of the child's powers, you shall fail in the object you are aiming at."[1] I think that the insignificant results of our present elementary schools, as compared with the amount of time, thought, and money, expended on them, and their want of real vitality, are to be mainly traced to this fundamentally false conception of elementary teaching as concerned only with the acquisition of the mere tools of knowledge.[2] By its fruits, or rather by its barren-

[1] "Of four-fifths of the scholars about to leave school, either no account, or an unsatisfactory one, is given by an examination of the most strictly elementary kind" (Report for 1869–'70). "We have never yet passed 20,000 in a population of 20,000,000 to the sixth standard; whereas old Prussia, without her recent aggrandizement, passed nearly 380,000 every year" (speech of Mr. Mundella, in the House of Commons, March 18, 1870). "What we call education in the inspected schools of England is the mere seed used in other countries, but with us that seed, as soon as it has sprouted, withers and dies, and never grows up into a crop for the feeding of the nations" (speech of Dr. Lyon Playfair, in the House of Commons, June 20, 1870). See the *Fortnightly Review* for August, 1873, and Payne in *Social Science Transactions for* 1872. If we should ever need—which God forbid!—a warning against the folly of substituting a sectarian for a national system of popular education, we may find it in the wretched perversion of English popular education in the hands of her Established Church.

[2] "What wonder if very recently an appeal has been made to statistics for the profoundly foolish purpose of showing that education is of no good—that it diminishes neither misery nor crime among the masses of mankind? I reply, Why should the thing which has been called education do either the one or the other? If I am a knave or a fool, teaching me to read and write won't make me less of either one or the other—

ness, we may know it; and I may add that it is because in our common schools we are completely outgrowing it, that day by day we see in them so much new life.

So much in regard to the debt which a liberal education is destined soon to owe to the progress of psychology, giving prevalence to truer views in regard to its rudimentary processes. Let me pass to the second influence, which is acting powerfully to modify all our previous conceptions of the subject; I mean the progress of modern linguistic science. I take this next in order because, contrary to the current of thought prevailing at the present moment, I believe the old doctrine will still be found to hold true, even after physical science shall have at last found its true place in the new education, that the study of that wonderful world of matter, which is the stage on which man plays his earthly part, wonderful as it is, is yet inferior in dignity and importance to the study of the being and doing of the actor who plays his part thereon. Scientific studies, though for the time being in the ascendant, yet, even when all their rights shall be accorded to them, will, in a well-balanced system, take their place a little below ethical studies. This, I say, as not believing in the current materialistic philosophy in any of its forms, but as being an immaterialist, as I must phrase it, since we have been robbed by unworthy and degrading associations of the word spiritualist. But, without raising any question of precedence between branches of study which are both essential to any true conception of a complete education, let me proceed to point out that the progress of linguistic science and of modern literature has totally transformed the educational character and position of the ethical studies of which they are the instrument and the embodiment. When the Revival of Learning gave birth to the present classical system of literary, or, as I have termed it, ethical liberal study, it did so by putting into the hands of scholars not merely two grammars as instruments of youthful mental discipline, as the advocates of the grindstone-system would fain have us believe, but two languages

unless somebody shows me how to put my reading and writing to wise and good purposes.

"Suppose any one were to argue that medicine is of no use, because it could be proved statistically that the percentage of deaths was just the same among people who had been taught how to open a medicine-chest, and among those who did not so much as know the key by sight. The argument is absurd; but it is not more preposterous than that against which I am contending. The only medicine for suffering, crime, and all the other woes of mankind, is wisdom. Teach a man to read and write, and you have put into his hands the great keys of the wisdom-box. But it is quite another matter whether he ever opens the box or not. And he is as likely to poison as to cure himself, if, without guidance, he swallows the first drug that comes to hand. In these times a man may as well be purblind as unable to read—lame, as unable to write. But I protest, that if I thought the alternative were a necessary one, I would rather that the children of the poor should grow up ignorant of both these mighty arts than that they should remain ignorant of that knowledge to which these arts are means."—(Huxley, "Lay Sermons" p. 43.)

that unlocked the stores of a whole new world of ethical thought, in the shape of the philosophy, the history, and the poetry contained in Greek and Roman literature. How assiduously those literatures were studied, how they leavened the whole thought of Europe, and mightily contributed to disperse the intellectual darkness and break the bonds of the spiritual despotism of the mediæval Church, we all know. Classical philosophy, history, poetry, and art, nourished the European mind, and were almost the sole foundation of its culture, through all the period during which the Latin and Teutonic races of Western Europe were slowly elaborating languages and literatures of their own. They were thus of necessity the main instrument of culture of the schools during the period when, save the obsolete scholastic philosophy, no other instrument was forthcoming; and I do not think it possible to overrate the debt which Western Europe owes to them. But gradually their educating influence has been absorbed, and in great measure exhausted, while partially, but by no means wholly, out of the nutriment they furnished have sprung the national languages and literatures which, as more and not less powerful educating instrumentalities, are to supersede them. It is to ignore the vast progress of the human mind since the days of Erasmus to try any longer to make classical learning stand in the same relation to the modern student that it stood in to Erasmus: and Erasmus, if he were alive today, would be the first to abandon the dead pedantries of the past for the fountains of new thought he would see flowing all round him.

When I say, then, that I think the languages and literatures of Greece and Rome are soon to be abandoned, as the sole or main instruments of that side of liberal culture which I have preferred to call ethical rather than literary, it is not that I do not fully recognize their value and beauty, or the vast service they have done in emancipating and training the mind of Western Europe: it is not that I do not recognize their value as among the specialties of liberal culture now. It is only as the sole or chief instruments of literary school training that I believe them to be superseded. So far from believing that they will be abandoned, I believe they will be more diligently and successfully studied in the future, when they will be left as a specialty in the hands of that small number of students who, at any time, in this modern world of ours, will of their own free choice[1] pursue them. As a

[1] The advocates of the classical theory sometimes point triumphantly to the number of students who, in colleges where the elective system prevails, freely, as they say, elect the classics; but it should be remembered that at present their whole previous school training has been by compulsion classical. Of science they are absolutely ignorant; and it is not strange that they should prefer to go on in studies whose elementary difficulties they have partially overcome, rather than engage in a belated encounter with new difficulties, of a sort for which their minds have been by their very previous training unfitted. The present system at some of our colleges of giving an election between science and literature, after admission, and no similar election in regard to preparatory studies, seems to me to be the very *reductio ad absurdum* of the grindstone-theory.

specialty for the few, classical studies still have a future before them, and we can ill afford to lose the elevating and refining influence exercised by their real votaries on those who do not directly pursue them; but as the main instruments of liberal culture their day seems to me to be nearly over.

In England, the very stronghold of the classical theory, classical study seems to be declining, in spite of, or rather through, the very means taken for keeping it alive. "I fear," says the late Earl of Derby, in the preface to his translation of the Iliad, "that the taste for and appreciation of classical literature are greatly on the decline." "The study of classical literature is probably on the decline," says Matthew Arnold, in his essay on translating Homer. "I cannot help thinking," says Mr. Sidgwick, of Cambridge, "that classical literature, in spite of its enormous prestige, has very little attraction for the mass even of cultivated persons at the present day. I wish statistics could be obtained of the amount of Latin and Greek read in any year, except for professional purposes, even by those who have gone through a complete classical curriculum. From the information that I have been able privately to obtain, I incline to think that such statistics, when compared with the fervent admiration with which we all speak of the classics, upon every opportunity, would be found rather startling.[1] And the truth is that the classical system of liberal education in England maintains its place, so far as it does maintain it, solely from the fact of its being a strictly protected system, through the enormous pecuniary prizes to which it is the sole means of access."[2]

Our own attempts to establish a liberal education seem to me to have thus far proved little less than abortive, because, following as we have in the steps of the mother-country, we cannot bring ourselves to abandon the old shadow for the new substance. For classical study has really dwindled into a shadow. Once it did mean the study of philosophy, of ethics, politics, history, poetry; now, for ninety-nine in a hundred of its students, it means none of these, but the mere dry study of grammar. The scholars of the Renaissance read their Plato in the original, and compassed sea and land to find a teacher who could unlock for them his treasure-house, but it was the treasure-house of his *thought*, not his grammar. The

[1] "Essays on a Liberal Education, ed. Farrar," p. 106.

[2] "The prizes proposed," says Dr. Donaldson ("Classical Scholarship and Classical Learning," p. 154), "are of enormous value. It is estimated that the first place in either Tripos (classics or mathematics) is worth, in present value and contingent advantages, about £10,000. . . . In classics, the majority of successful candidates for high honors have been under tuition in Greek and Latin for at least ten years."

The number of college fellowships at Oxford is somewhat over 300, and their average value £300 per annum. There are 400 scholarships, of an average value of £80, tenable for five years. The incomes of nineteen heads of houses are estimated at £23,000 a year. —(Heywood, in *Social Science Transactions* for 1871.) The sole access to all these pecuniary prizes has heretofore been through classical study.

scholars of the Revival, without Shakespeare or Milton, *had* to master Homer and Æschylus, or go without poetry altogether. With no wealth of modern literature, such as lies all round us, they were perforce classical students in order to be scholars. We cannot put back the wheels of time, and reproduce their circumstances. The mind of the generation refuses to be bound within antiquated limits: it will seek the new world of thought which lies before it. Try, therefore, to make classical scholars now of all liberally-educated boys, and you make nine-tenths of them into dunces or pedants. How many of the regiments of young men of this generation who have *gone through*, as it is well called, our older colleges, are real classical scholars? But the liberally-educated men of the times of the revival of learning were *real* classical scholars.

The Rev. Mark Pattison, Rector of Lincoln College, gives the following account of the present state of classical study even at Oxford: "We must not close our eyes to the fact that the honor-students" (that is to say, the students who have any expectation of winning the pecuniary prizes) "are the only students who are undergoing any educational process which it can be considered as the function of a university either to impart or to exact; the only students who are at all within the scope of the scientific apparatus and arrangements of an academical body. This class of students cannot be estimated at more than thirty per cent. of the whole number frequenting the university. The remaining seventy per cent. not only furnish from among them all the idleness and extravagance which are become a byword throughout the country, but cannot be considered to be even nominally pursuing any course of university studies at all."[1]

If the treasurer of a great manufacturing corporation were to report to his stockholders that, of all the raw material furnished, their machinery was capable of making only thirty per cent. into cloth, and that of a very peculiar and unsalable pattern; that the remaining seventy per cent. was not only not manufactured into any kind of cloth, but was much of it disseminated over the country, in the shape of deadly, poisonous rags, we should think there was something wrong in the machinery of that mill.

Thus it is that, classical education having dwindled into a shadow,[2]

[1] "Suggestions on Academical Organization," p. 230.

[2] "I think it incontestably true," says Prof. Sidgwick, "that for the last fifty years our classical studies (with much to demand our undivided praise) have been too critical and formal; and that we have sometimes been taught, while straining after an accuracy beyond our reach, to value the husk more than the fruit of ancient learning. . . . . This, at least, is true, that he who forgets that language is but the sign and vehicle of thought, and while studying the word knows little of the sentiment—who learns the measure, the garb and fashion of ancient song without looking to its living soul or feeling its inspiration, is not one jot better than a traveler in a classic land who sees its crumbling temples, and numbers, with arithmetical precision, their steps and pillars, but thinks not of their beauty, their design, or the living sculptures on their walls, or who

our colleges are looking about for a remedy, and a class of thinkers, just now, as we know, very influential, and looking to the substitution of the study of science as the sole remedy. Gentlemen, I have been long enough attached to a school of science to have been convinced, if I had ever doubted it, that science by itself is no remedy; that as there can never again be a liberal education, or the pretense of one, without the scientific element, so, on the other hand, scientific studies alone can never constitute a liberal education—scientific can never supersede ethical studies as its foundation. What, then, is the true remedy? I think it is evident. It is, along with scientific study, of whose true place I shall have more to say presently, to accept ethical studies in their new form, in the form of modern literatures and modern languages, and with classical studies as the special and subordinate, and not, as heretofore, the main and primary instrument. This is the great change which liberal education is silently undergoing, far more than it is a change from a literary to a scientific basis.

I know of no educational fallacy more common and more mischievous than that of enormously overrating the educating value of the process of acquiring the mere form of foreign languages, whether dead or living; yet it is in this barren study that we waste the precious time that should be employed, from the very beginning of school-life, in acquiring the substance of real knowledge. Languages, other than our own, are the useful, sometimes the necessary tools for acquiring knowledge; in the literatures of other tongues there reside elements of culture not to be found, or not to be found in the same perfection in our own, which may well repay the student who has time and perseverance sufficient really to attain them without too great a sacrifice. But to sacrifice an attainable education in *not* attaining them, what is it but to sow the barren sea-shore, to travel half a journey, to possess one's self of half an instrument useless without the other half. Languages alone are knowledge only to the professed philologist; we sacrifice a real education attainable through an instrument we already possess in the fruitless labor of giving our boys other instruments they will never make use of.

counts the stones in the Appian Way, instead of gazing on the monuments of the 'Eternal City.'"—("Discourse on the Studies of the University of Cambridge," fifth edition, p. 37.)

I find a corroboration of this view of the present state of classical study on this side of the water coming from a quarter where there can be no suspicion of too great leaning toward modern studies. Prof. Tayler Lewis is reported to have expressed himself in a recent pamphlet as follows: "He thinks it undeniable that there is danger that classical studies may be driven from our colleges; and, in looking for a reason for this, he seems to himself to have discovered it in the fact that we nowadays busy the undergraduate too much with grammar and too little with literature. . . . He illustrates his position by a comparison of the school of critical students even so great as Porson and Elmsley with the earlier schools. . . . The one school, admirable as it is, and deep as is our obligation to them, he regards as reading Homer for the sake of knowing Greek; the other as knowing Greek for the sake of reading Homer."—(*New-York Nation*, August 7, 1873.)

I think that we monstrously overrate the educating value of the mere process of learning other languages; but with the mother-tongue the case is altogether different. Here the mastery of form and substance can proceed *pari passu*. The mother-tongue is the only one which can stand to our modern liberal education in the relation in which the classical tongues stood to the scholars of the revival of learning. It might be said that Greek and Latin were mother-tongues to them as scholars, because it was through them alone that they reached the *thoughts* which really educated them. They were not brought up on empty words and barren syntax; they studied no grammars, for grammars were non-existent. Their minds were really nourished on the philosophy of Plato, and Cicero's eloquence, and Homer's poetry, and the lessons not the words they found in Tacitus and Thucydides. Now, when we have a philosophy, a history, a poetry, a law, an ethics, which embody all that is valuable in classical literature, together with all the progress of thought has produced through these later centuries, we not only fail to use them as those older scholars used their older instruments, really and efficiently, but we equally fail in using the older ones. We abandon both to feed our boys on a husk without a kernel. What wonder that our higher education is struck with barrenness?

When, therefore, I propose modern language-study instead of ancient, as a chief instrument of school education, I mean much more than the mere substitution of the study of some modern language as language, for some ancient language as language—German, for instance, instead of Greek, as has sometimes been suggested. This would be the mere semblance of a remedy, for the difficulty consists in the enormous overrating, by what I have called the grindstone-theory, of the educating value of the study of the mere structure and vocabulary of any strange language whatever. It has sometimes been doubted if we can ever really know more than one tongue, and certainly all our deeper mental processes go on in that one we know best. If that is a foreign one, it is because we have lost a mother to gain a step-mother; and a stepmother she will ever remain. What is very certain is, that too many of the recipients of our present education, in seeking to possess themselves of more than one language, end with having none whatever. Neglecting to develop their minds through the instrumentality of their mother-tongue, and never, therefore, really knowing it, they equally fail in providing themselves with any substitute; with Shakspeare's pedants, "they have been at a great feast of languages, and stolen the scraps."

My position, therefore, is that, so far as language-study shall form a part of the elementary discipline of the liberal education of the future, the centre and pivot of it all will hereafter be the scientific study of the mother-tongue. I anticipate something almost like ridicule for this proposition on the part of those—and they are many—who undervalue our native language so far as to believe it to be incapable

of becoming an instrument of disciplinary education. Time would fail me to go into a defense of this proposition. I will only say that I believe that it is precisely the change which the progress of modern philology is bringing about; that it is fitting modern languages, and preëminently our own, to become the instrument of a true mental discipline, so far as language-study can serve as such an instrument. On the one hand it is giving a scientific form to the study of the Teutonic element, and on the other there remains the still needful study of the Latin language—a study which certainly need not lose in force and vitality because it may no longer be pursued as the basis of a superstructure never to be erected, but shall have a definite object and be pursued for a practical end.

But far above and beyond its uses as language-study comes the advantage of the direct and immediate entrance it gives to those regions of thought in which the higher mental discipline really lies. Through the direct road of the real study of the mother-tongue, and that rhetorical and, above all, that real logical study which accompanies and forms a part of it, can the study of what we vaguely denominate literature, and that which we are beginning still more vaguely to denominate social science, but which yet, between them, contain the substance of all we most need to know of man as distinct from Nature, be made real portions of general knowledge—be transferred from being a possession in the hands of the few, to be reached only by an abstruse and difficult preparatory training, secrets unlocked by a key out of reach of the hands of the many, to being a part of the general inheritance of all men. For, to be so, they must be made primary and not secondary; in other words, that time and strength must be devoted to a fruitful study of modern thought and modern literature, which have heretofore been wasted in school and college on the futile attempt to master ancient thought and ancient literature. The rudiments of all those studies must be reckoned as the most valuable of all the elements of general elementary training, which, in their higher departments, and after liberal culture, diverging in various directions, form the substance of professional knowledge, both that of those professions now reckoned, and of all those hereafter to be reckoned liberal. For, what should liberal education be but the preparatory general stage for that work of life which all honest callings and professions carry on in diverse directions afterward? What is a professional education but a liberal education taking a special direction?

Can it now be said, with any truth, that our nominally-educated young men go out into the world equipped with that general knowledge of the sciences of law and government, and political economy, with that knowledge of ethics and philosophy, with that acquaintance with modern history and of the condition of the world they live in, and with that real taste for modern literature, which should form the equipments of every man calling himself educated? We

shall have to give a negative answer, just so long as we do not look upon all these as the truly disciplinary studies, and the elements of all these as the true elementary studies, the very school-studies fitted, above all others, for maturing the youthful mind, and filling it with true wisdom. So long as we insist upon approaching them through the operose and roundabout method of dead-language studies, school-days will flee away, and the object will *not* be accomplished. The great vice of our education, as has been well said, is its indirectness.

Combining the ideas which I have thus presented—1. That the study of foreign languages as languages, whether dead or living, holds a place in our present education-philosophy quite out of proportion to its real value and importance, and that it is the discipline of philosophy which we are indirectly aiming at, behind and through the discipline of language; 2. That it is through one tongue and not many that that discipline can best be imparted, inasmuch as that is the only one that can or will ever, by the majority of men, be really mastered; and, 3. That now, for the first time, there is the possibility, through the progress of modern linguistic science, of a scientific and systematic study of the mother-tongue—I arrive at the conclusion that we are presently to have, as a substitute for the exclusive or almost exclusive use of classical languages and literatures, as the main disciplinary element in liberal education, a systematic study of the English language and a recognition of its literature as primary, not secondary. And surely it is a strange phenomenon, if it be true, as a foreign scholar has recently maintained,[1] that the sovereignty of the world is hereafter to belong to the English language; and if it be true, as I think may well be maintained, that with this conquering language we possess the world's foremost literature, it is a strange phenomenon that we think them so little worthy of systematic study, give them a place so subordinate as instruments of our own liberal culture, that to-day we must go to the Germans for a good English grammar; to the French for the best, if a very defective, history of our literature. To my mind, no more striking illustration could be given of our want of a true education-philosophy.

How has it happened that we still lack such a philosophy? The answer to that question brings me to my next point, and the third new ingredient in the liberal education of the future, the element contributed by republicanism. I have said that the science of education was still in its infancy; I believe that it is only as a part of republican institutions that it can reach maturity. For the only true liberal education is the education of man as man; the only truly liberal system is that which can be applied to a whole nation, and such a system is only possible as a part of republican institutions. And, when we consider how short a time we have been living under them, and how crude and imperfect they still are, it is not strange that they have not yet pro-

[1] De Candolle.

duced what will be rather one of their maturest than one of their earliest fruits, a truly liberal education-system.

The history of our errors in regard to liberal education is a very plain one. They are the legacy of the mother-country from which we came, a mother-country which is just beginning to correct her own errors, even by the light of our limited experience. I wish to point out and emphasize the fact that republicanism revolutionizes our very conception of liberal education. All forms of liberal education of the past, and preëminently the one we borrowed from England, were forms of exclusive class-education. The idea of caste was involved in their very conception, to such a degree that the phrase, the liberal education of the people, was a contradiction in terms. The antithesis was, popular *versus* liberal education. There was the illiberal or servile education of the masses, designed to fit them for the humble station in which it had pleased Providence to place them, and to content them therewith; there was the liberal education of the exclusive learned professions, and the exclusive aristocratic class, which was liberal by virtue of its being the education of the rulers and not the ruled.[1] Now, republicanism, by converting the people into rulers, transfers to them the claim to a liberal education, which shall be universal. A transfer of the power alone, without a transfer of the privilege and the opportunity necessary to prepare for the exercise of it, cannot but be disastrous. If republicanism is to remain republicanism, and not degenerate into oligarchy or plutocracy, or end in anarchy, there must be one homogeneous education-system for all, and that one the highest attainable. The line of demarcation between liberal and illiberal must be obliterated, and what cannot be called liberal will be seen to be no education at all, but only a miserable counterfeit, by which privileged classes strive to perpetuate obsolete distinctions and indefensible abuses. For a republic, there can be but one system, and one set of schools; its education, begun on the lowest benches of its national primary schools, will one day be completed in the halls of its national universities. There will be no question as to the relative dignity of protected and unprotected professions, or callings, or classes, but all will

[1] "Religious teaching, from Episcopal charges down to the lessons of the Sunday-school, was, for a long time, as most of us can remember, in the habit of assuming that true religion was identified with government by the upper classes. . . . We may safely say that neither from Catholic nor from Protestant theology could we extract any formal witness in favor of the acquisition of political power by the humbler and more numerous classes. But the lower classes have not been content to stay in their places. Whatever the Church has taught, democracy has advanced irresistibly. Privilege after privilege has been wrenched out of the grasp of the favored classes, power has gradually descended, by the steps of the social stairs, until it has joined hands with the last class at the bottom. At the present time, it is a confessed fact, whether we like it or not, that the working-class, if it had peculiar interests, and were unanimously resolved to promote them, might dictate the policy of the empire."—(Rev. J. Llwellyn Davies, "Theology and Morality," pp. 10, 12.)

be reckoned liberal which train and educate the faculties of man as man.[1]

Now, the only conception of a liberal education that will satisfy these new conditions, the only conception of an education capable of becoming national and universal, at the same time that it is liberal, is that of a training of the national mind through the mother-tongue as the chief, and other tongues as the subordinate instruments, in the elements of all those branches of knowledge which, used in their rudiments as elements of general training, will develop, in their higher stages, into the objects of professional pursuits. Is there any other distinction than this between general and professional? In the infancy of knowledge, all callings, trades, and professions, are mysteries, whose secrets are carefully guarded from the uninitiated. Every mechanic belongs to his trade-guild, and has his trade-secrets. When Philip of Burgundy destroyed the little town of Dinant, in the Low Countries, the art of making copper vessels became, for the time being, a lost art. With the progress of general intelligence mystery falls away from simpler occupations, but still attaches to

[1] Nothing seems to me more thoroughly unrepublican and illiberal than the ground taken, by some who profess to be preëminently the advocates of liberal learning, against the promotion of higher education by grants from the state. Let the state promote the advancement of elementary education, they say, but for higher institutions to handle government moneys is only to touch pitch, and therewith be defiled. The distinction represents a remnant of aristocratic feeling, and springs from the idea that it is the duty of the educated, as a higher class, to take a paternal care for the masses; not the duty of the people, as a self-governing community, to give *itself* a liberal education. One cannot well see a higher function to be performed by the people, acting as a body, than to promote, by public action, its own higher education. If a line is to be drawn, beyond which its action should not reach, where shall it be drawn? Shall the people be allowed to promote the teaching of the three R's, and the four rules of arithmetic, but be forbidden to meddle with any thing beyond them? And in whose hands is the higher education to remain, in a country which has no established church? Is its progress forever to remain at the fitful mercy of an unenlightened and unsystematic private charity? The question as to the right means and methods of governmental action is undoubtedly a grave one, but no educational waste of state or national resources is ever likely to equal the waste arising from the capricious absurdity of private endowments. We have, indeed, of late, been startled by revelations of government corruption, but they have but a poor notion of the capacities of republicanism who are scared by them into that meanest of all political theories, the doctrine that the sole function of a government is merely to enact the part of head constable.

A far juster view is that propounded by one of the best of England's teachers. "As the condition of social, and, to some extent, political independence," says the Rev. Mark Pattison, "is necessary to prevent material interests from stifling and absorbing studies, so the condition of sympathy with the general mind is necessary both to sustain the required activity and to make the university a proper seminary for the education of the national youth. The nation does not hire a number of learned men to teach its children: it itself educates them, through an organ into which its own best intellect, its scientific genius, is regularly drafted. This education is, in short, nothing but the free action of life and society, localized, economized, and brought to bear."—("Oxford Essays for 1855," p. 259.)

what are called the learned professions. The layman has nothing to do with the study of the science of theology: that must be expounded to him by his priest. The layman has nothing to do with the science of medicine: he must be cured, or, more probably, killed, *secundum artem*, by his physician. The layman has nothing to do with the science of the law: it is his business to get into lawsuits, and it is the lawyer's secret how to extricate him. But these superstitions, the relics of an age of popular ignorance, are in their turn disappearing, as just ideas of what constitutes real knowledge begin to penetrate the minds of the whole people. It is seen that, so far from being mysterious, such knowledge is the very substance and material of sound education for all men; and the layman will no longer allow himself to be led blindfold by priest, or lawyer, or physician, for there is no longer any magical sacredness in their callings. And thus it comes about that a knowledge of physiology, which will help save the patient from any need of a physician; a knowledge of law, that shall obviate the necessity for lawsuits; a knowledge of political science and history worthy of men who have become their own rulers; a knowledge of political economy, that shall raise the honorable calling of the merchant to the dignity of a liberal profession; a knowledge of theology that shall save us the degrading spectacle of the unchristian quarrels of bigoted and superstitious sects—are reckoned more and more to be essential elements in *all* education. It is only on sound general knowledge, disseminated through the whole people by a liberal education of the whole people, that we shall ever build up professions, in regard to which we are not forced to entertain a doubt as to whether they are not on the whole more of a curse to us than a blessing.[1] And an education of this sort must be begun in the primary school, must have for its instrument the mother-tongue. It cannot be based on the study of Greek particles, or any amount of skill, either in the reading or the manufacture of Latin verses.

It is sometimes said that we, who have received this liberal education we decry, are ungrateful in thus decrying it, and unconscious of, and insensible to, all the benefits we derive from it. I am conscious of no ingratitude in agreeing with an eminent Scotchman who discusses these subjects, when he says, in speaking of knowledge and studies such as I have been enumerating: "I am sure no one seriously applies himself to such studies without wishing that he had given to them many hours in his youth which he fooled away, in obedience to his 'pastors

[1] "We need diffused knowledge in the community to sustain soundness of public opinion, and prevent the perversion of separate sciences into black arts and professional secrets."—(*Prof. Newman, on the Relations of Free Knowledge to Modern Sentiments.*)

The affirmation of Prof. Seeley is destined, I fear, to find an illustration in the experience of this country, "that a people will never have a supply of competent politicians until political science . . . is made a prominent part of the higher education."—*Inaugural Address on the Teaching of Politics.*

and masters,' in learning what he has now forgotten, and to recall which he would not now take the trouble to raise his little finger." [1] I was the docile and diligent receiver of such training as, in my youth, a "classical school" and our oldest New-England college had to give, and surely it is from no vanity that I say that I was also a recipient of their honors; and it is from the melancholy feeling that my formal education was so barren and empty when looked at from the standpoint of real life, and real thought, and real mental training, that I am so earnest an advocate of changes that I believe will give to future generations the reality instead of the pretense of an education.

I come now to the study of Physical Science, as from this time forward destined to play a wholly new part in our system of liberal education. Nowhere, save in that astonishing document, the Syllabus of his holiness Pope Pius IX., can any education-philosophy be found so benighted as not to recognize its value and importance. Yet I am far from believing that its true place, as a factor in the new education, has yet been determined. While, on the one hand, among the old high-and-dry advocates of the grindstone-system, certain merits and a subordinate place are beginning to be grudgingly allowed it, we are in danger, on the other hand, in this new country of ours, whose vast material resources are waiting for development through its instrumentality, rather of overrating than underrating its purely educational function. It is not as an economical instrument for the development of material wealth that I have here to deal with it, though that is a very important aspect, but considered as a factor in a system of education, and, as such, I claim for it no monopoly, but only a place as the indispensable complement to those ethical and linguistic studies which have heretofore monopolized the title of a liberal education, and which, from the absence of science from that form of education, have been reduced to their present effete and impotent condition. It is to the incorporation into it of the study of science that we are to look as the source of new life-blood.

You will not expect me to attempt to deal here with the great subject which forever occupies the minds of speculative thinkers, and never more than at the present moment—the true relations of the world of matter and the world of mind. That is too large a subject to be dealt with, though upon right views regarding it will greatly depend the correctness even of our educational theories. I will only say, that though I am as far as possible from being an adherent of any form of materialism, yet I believe that physical science is destined to be the great instrument of these modern days to give new forms to our philosophy and our theology—to give new forms to the same everlasting problems, but not to give us new philosophy or new theology. It will but cast old truths in new moulds, while it explodes old super-

[1] Mountstuart, E. Grant Duff, Inaugural Address as Rector of the University of Aberdeen, p. 22.

stitions by adding new truths to the old ones. Our conservatives may spare their anxieties. Not a truth the world gains is ever lost again; but they who, blindly believing they have all truth, oppose the new form which science is giving to all knowledge, will soon find themselves side by side with those old Dunsemen who could not believe in the last revival of learning.[1]

Now, if the study of physical science is to play a vastly more important part than it has hitherto done in all future schemes of liberal education, the first and most obvious consideration is that room must be found for it. Bearing in mind, as we must constantly do, that the word education stands for a strictly limited quantity, a limited amount of time, a definite amount of mental effort, if that time and mental effort have been wholly absorbed in one set of studies, it is very obvious that these must undergo modification and curtailment in order to make room for another set. And yet no error is at present more common or more disastrous than the attempt to introduce the new, without any disturbance of the older studies. Either the older curriculum did not absorb, as it professed to do, the whole of the student's mental energies, and was not therefore a complete education, or its requisitions must be diminished to make room for another set of solid, important, and disciplinary studies; or else it must be maintained that the new studies are not solid, important, and disciplinary, but only fitted to be the amusement of idle hours, and the lighter tasks with which gaps and intervals may be filled between the more solid, older ones. That this latter is really the view of the more thoroughgoing adherents of the classical system is pretty obvious. Thus the Rev. S. Hawtrey, one of the masters of Eton, says, in a recently-printed lecture: "It is for the masses that I fear, when I hear the cry that boys should be freed from the *severer* labor of studying language if it is distasteful, and therefore it is said unprofitable, and should learn, instead, something about the wonders which science has achieved in the present century."[2] It is very obvious that a writer who speaks

[1] "There is no reason for thinking that philosophy, which is only a just and perfect judgment on the bearings and relations of knowledge, should not be as generally attainable as a wise judgment in practical matters is. And should our universities, ceasing to be schools of grammar and mathematics, resume their proper functions, it will be found that a far larger proportion of minds than we now suspect are capable of arriving at this stage of progress. For, be it again repeated, it it not a knowledge, but a discipline that is required; not science, but the scientific habit; not erudition, but scholarship. And those who have not leisure to amass stores of knowledge to master in detail the facts of science, may yet acquire the power of scientific insight, if opportunity is afforded them. It is the want of this discernment and the absence of the proper cultivation of it which produce that deluge of crude speculation and vague mysticism which pervades the philosophical and religious literature of the day, and which is sometimes wrongly ascribed to the importation of philosophy itself and its recent unreasonable intrusion on our practical good sense. The business of the highest education is not to check, but to regulate this movement; not to prohibit speculation, but to supply the discipline which alone can safely wield it."—(Pattison, in "Oxford Essays for 1855," p. 258.)

[2] "A Narrative-Essay on a Liberal Education," p. 29.

of the severer study of language has very little comprehension of the true nature of the study of science, or else, like the public orator of Cambridge, in his "tonic" theory, confounds together the ideas of severity and distastefulness. And Mr. Hawtrey's very childish conceptions in regard to the teaching of science are further exemplified when he goes on to ask: "Would there not be great danger of boys becoming less vigorous-minded than they are? . . . Will their becoming acquainted with a string of scientific results stand them instead of the mental training they now get?"

Thus we see that the highest conception a master of Eton has of the study of science is that it is "becoming acquainted with a string of scientific results." I need not pause before this audience to refute such a notion. If the study of modern science did not call for the exercise of all the highest faculties of man; if it did not give an exercise such as no other study gives to his reasoning as well as his observing powers; if without it the very study of language itself did not become empty and barren; if a knowledge of it were not necessary to the solution of all the profoundest philosophical problems with which the mind of man in these generations is occupied—then, indeed, a question might be raised as to the propriety of its introduction into the curriculum of liberal study. But if it is this, and more than all this, then it claims more than a subordinate place; it is no toy for idle hours, no subject to fill up gaps and intervals of time. It claims a right to no less than a full half of all available time and power; of time for training the student's senses—all left by our older training in worse than Egyptian darkness—of power to be employed in training the reasoning faculties, by processes as rigorous as any the older studies can boast of. Nothing less than this will satisfy the demands of science as an element in modern liberal education.

I have already indicated what seems to me to be the only way by which room can be found for the real introduction of science into our scheme of studies. By removing Greek wholly from the list of general studies to that list of specialties which make up our completed conception of the higher education, after it diverges in different directions; by relegating Latin to a subordinate instead of a primary place in language-training, we shall find room to place science on an equal footing with literature as an instrument of general liberal culture; and I see no other way. And this scheme will have this further advantage, that, for all who carry their education beyond its rudimentary stages, it will afford ample time and opportunity for the *real* mastery of at least two of the leading modern languages besides our own: for French, the modern daughter of the Latin—for German, a kindred Teutonic dialect closely related to our own. I am aware that such a scheme for the teaching of modern languages, including our own, so systematically and scientifically, as that the mental discipline derived from it shall not be inferior to that derived from the teaching

of the classics, implies an adaptation of the results of modern philology to the purposes of elementary instruction such as has hardly yet been realized; implies a body of teachers of modern linguistic science such as hardly yet exist—teachers whose instruction shall not be inferior in philosophic breadth and thoroughness to the very best of classical teaching. If we have few such books or teachers yet, there are indications on every hand that we very soon shall have them in the greatest abundance, and that modern language-teaching and English language-teaching are very soon to be relieved of the reproach of empiricism which has heretofore prevented them from taking the leading place which, as educating instrumentalities, rightfully belongs to them.

And, finally, time will also be gained by utilizing the at present barren and empty study of mathematics. If there is any thing more preposterous than the abuse of grammar, in our present grindstone-system, it is the abuse of mathematical study. Rightly viewed, the mathematics are the key to scientific, as language is the key to ethical study. At present, both are used as mental tread-mills, unprofitable mental gymnastics, keys to unlock empty chambers never destined to be filled; for their sole value is thought to lie in the mental exercise they give. Robbed thus of all living connection with other knowledge, they become the most disgustful, and therefore the most valueless, of mental exercise. Put into vital connection from the very outset with those great sciences, of whose laws they are only the symbolic language, the mathematics spring into life. By themselves, they are to most minds a series of barren puzzles, hardly rising in dignity or educational value above the game of chess, and so remote from all those paths in which the human mind naturally travels, that it is only one peculiarly-constituted mind in ten thousand that, in their abstract form, can pursue them with either pleasure or profit.[1] Looked at as the language of the laws which govern the world of matter, and used as the instruments to unlock so many of its secrets, they lose their disgustfulness, and become a necessary, if a narrow and partial instru-

[1] Since writing the above, I have met with an unexpected corroboration of this view in the writings of an eminent mathematician. "I am not likely," says Mr. Todhunter, the distinguished mathematical teacher of English Cambridge, "to underrate the special ability which is thus cherished (by competitive examinations), but I cannot feel that I esteem it so highly as the practice of the university really suggests. It seems to me at least partially to resemble the chess-playing power which we find marvelously developed in some persons. The feats which we see or know to be performed by adepts at this game are very striking, but the utility of them may be doubted, whether we regard the chess-player as an end to himself or to his country."—("The Conflict of Studies," p. 19.) What the teaching of the higher mathematics appears to have become at Cambridge, that the teaching of their elements, divorced from their natural connection with the teaching of physical science, becomes in our schools and colleges.

On the fallacy that it was the mathematical studies at Cambridge of certain eminent graduates of Cambridge that was the cause of their eminence, and for some wholesome common-sense, in regard to the general subject, see a recently-published pamphlet, "The Mathematical Tripos," by the Rev. H. A. Morgan, Fellow of Jesus College, Cambridge.

ment of training—one which performs certain disciplinary functions which no other instrument can perform so well; but it is only live mathematics, not dead mathematics, mathematical in vital connection with physical science, not prematurely thrust as an ugly skeleton alone upon the youthful mind, upon the pretense that its sole object is their mental discipline. And, on the other hand, it is only for the study of physical science, pursued by vigorous scientific methods, and in rigorous, logical, and mathematical ways, that we can claim for it a place as a disciplinary, that is, a real study. As the mere becoming acquainted with a string of scientific results, it may well be left to the contempt of the Rev. Mr. Hawtrey.

But the chief influence of modern science upon liberal education will be its ethical influence. Its discoveries are transforming man's conception of the earth he lives on, and of his history and his work upon it. Before man acquires the control of matter, through ascertainment of the laws that govern it, his life on earth is poor, narrow, and full of hardship, and his earthly relations full of pain. So long as that state continues, life on earth must seem to him a small matter, and its opportunities for growth not much worth considering; it is only here and there that a philosopher in his closet attains to some realization of the capacities that lie hidden in it. War and savage occupations consume the days of the mass of men, and no culture is possible save the perverted culture of the cloister. But the advent of physical science means the emancipation of the masses into the privileges of intellectual life. From a battle-ground, the earth is transformed into a school-room, written all over with hieroglyphics, no longer mysterious, but to which mankind have found the key: and, with the right use of the secrets thus unfolded, will come to the mass of men that accession of material wealth which will give the leisure and opportunities that have heretofore been the monopoly of privileged classes.

It is not wonderful that men, at first, are carried away with the contemplation of its lower uses, even sometimes to the making them the sole end of education. It is but a reaction from the opposite extreme, only a dazzling of eyes with a flood of new light. Presently we shall look about us, and find the old relations of things not greatly altered. Matter is not going to supplant mind because we are learning so much more about it; whether we understand or do not understand the laws that govern it, matter remains the servant of mind, to educate it and do its bidding. The higher uses of science will still be spiritual uses. It has not come into the world merely to carry us faster through space, merely that we may sleep more softly and eat and drink more luxuriously, nor will education become the mere teaching how to do these things. It is with the spiritual educating function alone that we have to deal when we consider it as an element in liberal education.

And thus one great result of the new form into which modern science is casting all our conceptions of education will be a vastly higher estimate of the educating value of those pursuits in life which are concerned with material things, and a distinct recognition of them as included among the liberal professions. It is interesting to observe how the list of liberal professions enlarges with the advance of civilization. At first the priest is the divinely-appointed monopolist of all higher knowledge; by degrees he is joined by the lawyer, as the interpreter still of a divinely-established code; it is much later and only after a certain amount of progress has been made in physical knowledge that the importance of his function raises the physician's art to the dignity of a liberal profession; and that more at first through a superstitious belief in the power of his spells and his magic than from respect to the small reality of his science. Now that science has so far entered into other callings as to make them worthy fields for the exercise of the highest faculties, all those pursuits which have for their aim the improvement of man's earthly condition will take their due rank in the list of liberal professions, and the chemist, the engineer, the architect, and the merchant, will have their appropriate liberal educations as much as this clergyman, the lawyer, or the physician. It may safely be affirmed that that view of earthly life of mediæval ascetics which has left its traces so deeply imprinted in much of our sectarian theology is fast vanishing like an ugly dream forever. The intellectual and moral aspect of material pursuits is fast gaining, through the significance given to them by modern science, a predominance over their mere material aspect. The worker in material things is more and more, as the days go by, compelled to be an intellectual being even in order to be a worker, and it is because the study of and working in material things now give scope for the energies of great intellects, that they more and more absorb them. Whoever continues to believe in the antithesis between matter and spirit, and insists upon looking on the world of material things as of necessity the world of the devil, must see in this tendency only disaster to all our higher interests; but whoever sees that it is the true function of modern science to spiritualize material things by enabling us to put them to higher uses, will see in science not the great antagonist but the great hope of the religion and the philosophy of the future.[1]

The advocates of the classical theory are never weary of reproaching their opponents with opinions which, as they say, degrade the dignity of true learning, by making it subservient to mere utilitarian

[1] The spirit of the older education is well represented in the following extract from a work of that learned and arrogant pedant, the late Dr. Donaldson. He says: "If, then, the education of the whole community is so dependent on that of the *upper classes*, and if these owe their normal influence to the circumstances which enable them to escape the trammels of material interests, it must follow that the liberal education which is the peculiar attribute of the highest order ought to consist in the literature which humanizes and generalizes our views, and not in the science which provides for the increase of opulence

aims. If to try by knowledge to make this world a better place to live in, and to teach men how to make the highest and best use of it be utilitarianism, then I make bold to say that any knowledge that cannot make good its claim to such usefulness is worse than utilitarian, for it is useless knowledge. The charge that is meant to be brought is this, that none but the advocates of classical learning have or can have the higher ends of life in view in planning schemes of education; that all other systems look solely to the stomach or the pocket. I do not know whether such charges are not too hackneyed to waste words on; certainly I can conceive of no lower form of utilitarian abuse of education than the pursuit of fellowships by the cramming of Greek and mathematics for the competitive examinations of an English university. On the other hand, the truly liberal learning of England is to be found more than anywhere else at this moment with that noble band of students of science who are virtually excluded from all such preferments.[1] It is not a difference in studies that constitutes them liberal or illiberal; it is a difference in the spirit in which all studies may be pursued. The study of chemistry and the study of Greek particles may be equally base or equally noble, according as they are pursued worthily or unworthily, with a selfish eye to the loaves and fishes, or with an aim at the higher rewards of true culture, and the higher advancement of man's estate. But I think we may well leave aside this stupid charge of utilitarianism. It comes nowadays only from those benighted pedants who are wholly ignorant of the true spirit of modern science.

I have left myself no room, even if I were competent, to speak of the last ingredient in any just scheme of modern liberal education—the study of art, æsthetic culture. I fear there will be abundance of time to develop that side of the question in this country before it is in any

and comfort. The higher training of our youth must not be that of a polytechnic school. We want such institutions, no doubt, for we need observers and surveyors, engineers and artillerymen to do the work, which can best be performed by such *intelligent automatons*." —("Classical Scholarship and Classical Learning," p. 90.)

[1] "I believe there can be no doubt that the foreigner, who should wish to become acquainted with the scientific or the literary activity of modern England, would simply lose his time and his pains if he visited our universities with that object. . . . England can show now, as she has been able to show in every generation since civilization spread over the West, individual men who hold their own against the world, and keep alive the old tradition of her intellectual eminence. But in the majority of cases these men are what they are in virtue of their native intellectual force, and of a strength of character which will not recognize impediments. They are not trained in the courts of the temple of science, but storm the walls of that edifice in all sorts of irregular ways, and with much loss of time and power, in order to obtain their legitimate positions. Our universities not only do not encourage such men, do not offer them positions in which it should be their highest duty to do thoroughly that which they are most capable of doing; but, as far as possible, university training shuts out of the minds of those among them who are subjected to it the prospect that there is any thing in the world for which they are specially fitted."—(Huxley, "Lay Sermons," p. 55.)

danger of becoming a practical one. Yet, in the shape of elementary drawing, the rudiments of art are beginning to take their proper place in our schools as a necessary and indispensable element of all real education, and the art galleries and the foreign musicians of a few of our older cities are beginning to exert their influence, if a slight one, in introducing higher ideas of the importance of art into our new country. They will have but a limited influence, however, till the study of the fine arts takes its proper place among us as a necessary element in every conception of true education.

There is one form of art-study, and that, perhaps, the highest, which is open to all, even to the humblest student, and the most elementary school, and that is, the study of poetry. It is a prime element in any conception of a liberal education, which shall take as its chief instrument of language-training the mother-tongue, that the real study of English poetry will take the place of the pretended study of classical poetry. When that time comes, we may expect to see the great poets of our native tongue exerting the same influence in the culture and training of our children that Homer and Æschylus really exercised over that of the Greeks. We shall not know what that influence is capable of becoming till we have a *real* study of English, in place of a sham study of classical literature. The great Greek philosopher says that poetry is truer than history. Sure I am that we shall one day come to see that in neglecting to train and cultivate the imagination, we are neglecting the most powerful of all the faculties.

Ladies and gentlemen, I have thus given you, very feebly and imperfectly, an outline of a scheme of liberal education, applicable to a whole free people, which shall use that people's own language on the one hand, and the great instrument of modern science on the other, as its chief disciplinary instruments, in lieu of the obsolescent scheme for a liberal class education, based upon the study of dead languages as its chief educating instrument. As a means for realizing that scheme for the liberal education of the whole people, I believe that we must sooner or later have in this our republic one homogeneous system of free schools, from the lowest to the highest. The first step of that education will be taken from the benches of the primary school, its last lessons learned in the lecture-rooms and laboratories of universities, free from all trammels of sectarian narrowness or class distinctions. It will be from first to last a homogeneous, logically compacted, consistent training in all available knowledge, to all attainable wisdom, free to all men and all women to pursue to the extent the faculties God has endowed them with will carry them. It is a Utopian vision, you will say, this of popular liberal education. Say rather it is the necessary safeguard and supplement of free institutions; to despair of it is to despair of the republic.

THE GROWTH OF SALMON.

By C. E. FRYER.

SINCE the time of Magna Charta it has been an object, directly or indirectly, on the part of the Legislature, to protect the supplies of salmon with which our rivers used to be so abundantly stocked: but, notwithstanding the laws which have at various times been enacted, this fish gradually became scarcer till, in 1861, all the old laws were repealed, and fresh and more stringent regulations made for protecting and increasing our salmon-supplies. In addition to the fostering care which is bestowed, under the Salmon Fishery Acts of 1861 and 1865, on the fish in the rivers, means have been adopted to artificially rear salmon, so as to increase their numbers more rapidly than could be done in the ordinary course of Nature. Mr. Frank Buckland has been the pioneer of this system of artificial breeding of salmon and trout, and the experiments and operations which have been carried on during the last few years have thrown great light on the hitherto unknown habits of this "king of fish."

Any one who looks into the fishmongers' shops just now can see what a clean, fresh-run salmon, ready for cooking, is like—a silvery, plump creature, whose "lines" are made for speed in water, and whose graceful curves give the completest idea of vigor and strength in stemming a rapid current of water.

But very few people, probably, know what sort of an appearance this beautiful fish presents in its infancy. Hidden away during that period in the upper waters of our salmon rivers, and ultimately in the depths of the sea, it is lost to sight till it grows large enough to be taken by the salmon-nets; and, until lately, very little was known of its natural history, or of its habits, though the experience of the last few years has revealed many interesting facts concerning the development of this fish, through the egg, fry, smolt, and grilse stages, till it becomes a full-grown salmon.

FIG. 1. FIG. 2.

NEW-LAID SALMON EGG. EGG AFTER ABOUT 35 DAYS.

Fig. 1 represents the egg—natural size—of a salmon just laid. Each female salmon carries, on an average, 800 to 900 of such eggs to every pound of her weight. They are generally of a pinky opal color, elastic to the touch, covered with a soft, horny membrane, with a mi-

nute opening through which a particle of the spawn—the soft roe—of the male fish enters, and the egg is fertilized. From this moment the young fish gradually develops, under the influence of the cold running water. At the end of about thirty-five days—more or less, according to the temperature, which should be about 40°—two little black specks can be seen, as at Fig. 2, which are the eyes of the embryo fish; the vertebræ may be discerned in the form of a faint red line, and a small red globule, which shortly afterward appears, represents the vital organs of the embryo fish.

At the end of about 80 to 100 days from the deposition of the egg the fish has so increased in size that it bursts the "shell" and makes its *début* in the form represented at Fig. 3. The sac or umbilical vesi-

FIG. 3.

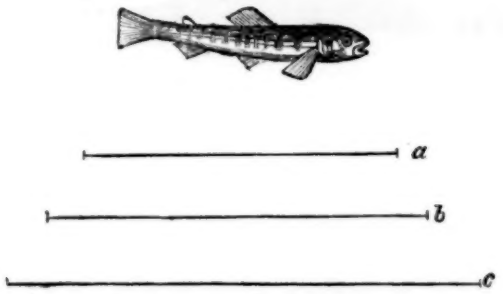
FISH COMING OUT OF EGG.

cle attached to the under part of the fish contains a secretion resembling albumen, which affords nourishment to the infant fish for the first six weeks or so of its existence. By that time it is quite absorbed, and for the first time we see a perfect fish, Fig. 4, with its fins, gills, and scales, which have hitherto been present, but imperceptible except under the microscope, fully formed: and now the young salmon begins to feed. His growth is not very rapid for some months, the lines *a*, *b*, *c*, representing the average length of a salmon at two, three, and four months old. At two years old the fish is about nine to twelve inches long.

As soon as they are large enough and strong enough, the "smolts," as they are now called, descend to the sea; here they are lost sight of until they return up the river as "grilse." The actual duration of their stay in the sea is not yet known, from one to three years being variously estimated as the probable length of time. The object of this migration to the sea is to find the food which is necessary for the secretion of the fat of the fish, who lives on the *Infusoria*, smaller fish and crustaceans, and the spawn of sea-fish, which abound in our seas. The length of their stay in salt-water is regulated, no doubt, by various circumstances, and is not the same in every case. When the salmon has laid up a sufficient supply of fat in its body and on its pyloric appendages, which are a wonderful provision of Nature for the secretion of an amount of fat sufficient to supply it during its so-

journ in fresh waters, it ascends the river, its roe or spawn developing as it ascends; till, about Christmas-time, or sometimes earlier, it reaches the shallow head-streams of the river, in the gravelly beds of which it deposits its eggs, returning immediately afterward to the sea, no longer in the bright, plump, muscular condition in which it ascended, but a lean, lank, ugly, wounded beast, which one would hardly recognize as *Salmo salar*. Fig. 5 represents the head of a "kelt," as those salmon are called which have newly spawned. The curved projection, or hook, on the lower jaw, is a cartilaginous membrane, the use of which nobody knows. The fish is in a very weakly condition, as his fat is gone, and he perhaps assumes this appearance to frighten other animals, which might otherwise be tempted to attack him. The drawing is taken from the photograph of a salmon, weighing twenty pounds, which was found dead on the banks of one of our Welsh rivers.

FIG. 4.



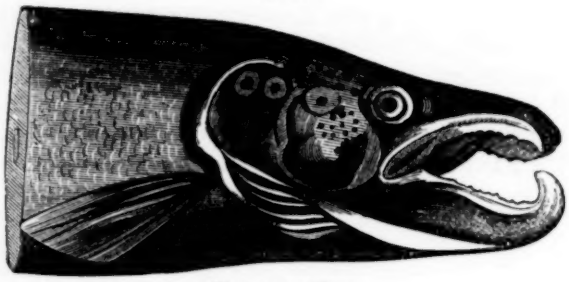
YOUNG SALMON SIX WEEKS OLD.
a, *b*, *c*, size of salmon at two, three, and four months respectively.

This fish, had it survived, would have returned to sea, recovered its fat, and presently come back worth £2 or £3, whereas, by dying in this condition, it was worth nothing. It had, however, done its duty by depositing perhaps 16,000 eggs. Only a very small percentage, however, of the eggs laid ever become adult fish. Floods wash them out of their gravel nests; ducks, and other birds, eat them; beetles and various insects attack them; they are smothered with mud, or left high and dry on the shore; the young fish are poisoned by pollutions, or diverted into mill-leats and canals, and so lost; trout eat them wholesale; in fact, the whole of their earliest existence is a very living death, and it is a wonder, with all the ordeals they have to pass through, that we have any salmon left. To kill them legitimately for food for ourselves is bad enough, and we ought to do all we can to protect them when young.

In the artificial system of breeding salmon the adult fish are caught just as they are on the spawning-beds, and the eggs taken from them; the ova and milt are properly mixed together, and the eggs placed in

troughs of water so arranged as to imitate as closely as possible the natural conditions necessary for the development and growth of the fish. Properly managed, ninety per cent. of the eggs will hatch out: the young fish are turned into the river when they are about a year old; if they can be kept two years in tanks large enough, with plenty of running water, so much the better for the prospect of their reaching the sea in safety.

FIG. 5.



HEAD OF A KELT.

When we can make up our minds to keep all our pollutions out of our rivers, and build "salmon-ladders" over all the wears, so as to give the fish a fair field, and enable them to run up-stream unimpeded, then, and then only, shall we see salmon as plentiful throughout the country as it is said to have been in the North a century ago, when apprentices are reputed to have stipulated in their indentures that they should be fed on salmon not more than three days a week. Without this, all our efforts to stock our barren rivers with artificially-bred fry will prove comparatively unavailing.—*Nature.*

PSYCHOLOGY OF THE SEXES.[1]

BY HERBERT SPENCER.

ONE further instance of the need for psychological inquiries as guides to sociological conclusions may be named—an instance of quite a different kind, but one no less relevant to questions of the time. I refer to the comparative psychology of the sexes. Women, as well as men, are units in a society, and tend by their natures to give that society certain traits of structure and action. Hence the question, Are the mental natures of men and women the same? is an important one to the sociologist. If they are, an increase of feminine influence is not likely to affect the social type in a marked manner. If they are

[1] Conclusion of chapter on Mental Science and Sociology.

not, the social type will inevitably be changed by increase of feminine influence.

That men and women are mentally alike, is as untrue as that they are alike bodily. Just as certainly as they have physical differences which are related to the respective parts they play in the maintenance of the race, so certainly have they psychical differences, similarly related to their respective shares in the rearing and protection of offspring. To suppose that along with the unlikenesses between their parental activities there do not go unlikenesses of mental faculties, is to suppose that here alone in all Nature there is no adjustment of special powers to special functions.[1]

Two classes of differences exist between the psychical, as between the physical, structures of men and women, which are both determined by this same fundamental need—adaptation to the paternal and maternal duties. The first set of differences is that which results

[1] The comparisons ordinarily made between the minds of men and women are faulty in many ways, of which these are the chief:

Instead of comparing either the average of women with the average of men, or the *élite* of women with the *élite* of men, the common course is to compare the *élite* of women with the average of men. Much the same erroneous impression results as would result if the relative statures of men and women were judged by putting very tall women side by side with ordinary men.

Sundry manifestations of nature in men and women are greatly perverted by existing social conventions upheld by both. There are feelings which, under our predatory *régime*, with its adapted standard of propriety, it is not considered manly to show; but which, contrariwise, are considered admirable in women. Hence, repressed manifestations in the one case, and exaggerated manifestations in the other; leading to mistaken estimates.

The sexual sentiment comes into play to modify the behavior of men and women to one another. Respecting certain parts of their general characters, the only evidence which can be trusted is that furnished by the conduct of men to men, and of women to women, when placed in relations which exclude the personal affections.

In comparing the intellectual powers of men and women, no proper distinction is made between receptive faculty and originative faculty. The two are scarcely commensurable; and the receptivity may, and frequently does, exist in high degree where there is but a low degree of originality, or entire absence of it.

Perhaps, however, the most serious error usually made in drawing these comparisons is, that of overlooking the limit of normal mental power. Either sex under special stimulations is capable of manifesting powers ordinarily shown only by the other; but we are not to consider the deviations so caused as affording proper measures. Thus, to take an extreme case, the mammæ of men will, under special excitation, yield milk: there are various cases of gynæcomasty on record, and in families, infants whose mothers have died have been thus saved. But this ability to yield milk, which, when exercised, must be at the cost of masculine strength, we do not count among masculine attributes. Similarly, under special discipline, the feminine intellect will yield products higher than the intellects of most men can yield. But we are not to count this as truly feminine if it entails decreased fulfillment of the maternal functions. Only that mental energy is normally feminine which can coexist with the production and nursing of the due number of healthy children. Obviously a power of mind which, if general among the women of a society, would entail disappearance of the society, is a power not to be included in an estimate of the feminine nature as a social factor.

from a somewhat earlier arrest of individual evolution in women than in men, necessitated by the reservation of vital power to meet the cost of reproduction. Whereas, in man, individual evolution continues until the physiological cost of self-maintenance very nearly balances what nutrition supplies, in woman, an arrest of individual development takes place while there is yet a considerable margin of nutrition: otherwise there could be no offspring. Hence the fact that girls come earlier to maturity than boys. Hence, too, the chief contrasts in bodily form: the masculine figure being distinguished from the feminine by the greater relative sizes of the parts which carry on external actions and entail physiological cost—the limbs, and those thoracic viscera which their activity immediately taxes. And hence, too, the physiological truth that, throughout their lives, but especially during the child-bearing age, women exhale smaller quantities of carbonic acid, relatively to their weights, than men do; showing that the evolution of energy is relatively less as well as absolutely less. This rather earlier cessation of individual evolution thus necessitated, showing itself in a rather smaller growth of the nervo-muscular system, so that both the limbs which act and the brain which makes them act are somewhat less, has two results on the mind. The mental manifestations have somewhat less of general power or massiveness; and beyond this there is a perceptible falling short in those two faculties, intellectual and emotional, which are the latest products of human evolution—the power of abstract reasoning and that most abstract of the emotions, the sentiment of justice—the sentiment which regulates conduct irrespective of personal attachments and the likes or dislikes felt for individuals.[1]

After this quantitative mental distinction, which becomes incidentally qualitative by telling most upon the most recent and most complex faculties, there come the qualitative mental distinctions consequent on the relations of men and women to their children and to one another. Though the parental instinct, which, considered in its essential nature, is a love of the helpless, is common to the two; yet it is obviously not identical in the two. That the particular form of it which responds to infantine helplessness is more dominant in women than in men, cannot be questioned. In man the instinct is not so habitually excited by the very helpless, but has a more generalized relation to all the relatively weak who are dependent upon him. Doubtless, along with this more specialized instinct in women, there go special aptitudes for dealing with infantine life—an adapted power of intuition and a fit adjustment of behavior. That there is here a mental specialization, joined with the bodily specialization, is undeniable;

[1] Of course it is to be understood that in this, and in the succeeding statements, reference is made to men and women of the same society, in the same age. If women of a more-evolved race are compared with men of a less-evolved race, the statement will not be true.

and this mental specialization, though primarily related to the rearing of offspring, affects in some degree the conduct at large.

The remaining qualitative distinctions between the minds of men and women are those which have grown out of their mutual relation as stronger and weaker. If we trace the genesis of human character, by considering the conditions of existence through which the human race passed in early barbaric times and during civilization, we shall see that the weaker sex has naturally acquired certain mental traits by its dealings with the stronger. In the course of the struggles for existence among wild tribes, those tribes survived in which the men were not only powerful and courageous, but aggressive, unscrupulous, intensely egoistic. Necessarily, then, the men of the conquering races which gave origin to the civilized races, were men in whom the brutal characteristics were dominant; and necessarily the women of such races, having to deal with brutal men, prospered in proportion as they possessed, or acquired, fit adjustments of nature. How were women, unable by strength to hold their own, otherwise enabled to hold their own? Several mental traits helped them to do this.

We may set down, first, the ability to please, and the concomitant love of approbation. Clearly, other things equal, among women living at the mercy of men, those who succeeded most in pleasing would be the most likely to survive and leave posterity. And (recognizing the predominant descent of qualities on the same side) this, acting on successive generations, tended to establish, as a feminine trait, a special solicitude to be approved, and an aptitude of manner to this end.

Similarly, the wives of merciless savages must, other things equal, have prospered in proportion to their powers of disguising their feelings. Women who betrayed the state of antagonism produced in them by ill-treatment would be less likely to survive and leave offspring than those who concealed their antagonism; and hence, by inheritance and selection, a growth of this trait proportionate to the requirement. In some cases, again, the arts of persuasion enabled women to protect themselves, and by implication their offspring, where, in the absence of such arts, they would have disappeared early, or would have reared fewer children. One further ability may be named as likely to be cultivated and established—the ability to distinguish quickly the passing feelings of those around. In barbarous times, a woman who could, from a movement, tone of voice, or expression of face, instantly detect in her savage husband the passion that was rising, would be likely to escape dangers run into by a woman less skilled in interpreting the natural language of feeling. Hence, from the perpetual exercise of this power, and the survival of those having most of it, we may infer its establishment as a feminine faculty. Ordinarily, this feminine faculty, showing itself in an aptitude for guessing the state of mind through the external signs, ends simply in intuitions formed without assignable reasons; but when, as happens in

rare cases, there is joined with it skill in psychological analysis, there results an extremely remarkable ability to interpret the mental states of others. Of this ability we have a living example never hitherto paralleled among women, and in but few, if any, cases exceeded among men.

Of course, it is not asserted that the specialties of mind here described as having been developed in women, by the necessities of defense in their dealings with men, are peculiar to them: in men also they have been developed as aids to defense in their dealings with one another. But the difference is, that, whereas, in their dealings with one another, men depended on these aids only in some measure, women in their dealings with men depended upon them almost wholly—within the domestic circle as well as without it. Hence, in virtue of that partial limitation of heredity by sex, which many facts throughout Nature show us, they have come to be more marked in women than in men.[1]

One further distinctive mental trait in women springs out of the relation of the sexes as adjusted to the welfare of the race. I refer to the effect which the manifestation of power of every kind in men has in determining the attachments of women. That this is a trait inevitably produced will be manifest, on asking what would have happened if women had by preference attached themselves to the weaker men. If the weaker men had habitually left posterity when the stronger did not, a progressive deterioration of the race would have resulted. Clearly, therefore, it has happened (at least since the cessation of marriage by capture or by purchase has allowed feminine choice to play an important part) that, among women unlike in their

[1] As the validity of this group of inferences depends on the occurrence of that partial limitation of heredity of sex here assumed, it may be said that I should furnish proof of its occurrence. Were the place fit, this might be done. I might detail evidence that has been collected showing the much greater liability there is for a parent to bequeath malformations and diseases to children of the same sex, than to those of the opposite sex. I might cite the multitudinous instances of sexual distinctions, as of plumage in birds and coloring in insects, and especially those marvelous ones of dimorphism and polymorphism among females of certain species of Lepidoptera, as necessarily implying (to those who accept the Hypothesis of Evolution) the predominant transmission of traits to descendants of the same sex. It will suffice, however, to instance, as more especially relevant, the cases of sexual distinctions within the human race itself, which have arisen in some varieties and not in others. That in some varieties the men are bearded, and in others not, may be taken as strong evidence of this partial limitation of heredity; and, perhaps, still stronger evidence is yielded by that peculiarity of feminine form found in some of the negro races, and especially the Hottentots, which does not distinguish to any such extent the women of other races from the men. There is also the fact, to which Agassiz draws attention, that, among the South American Indians, males and females differ less than they do among the negroes and the higher races; and this reminds us that among European and Eastern nations the men and women differ, both bodily and mentally, not quite in the same ways and to the same degrees, but in somewhat different ways and degrees—a fact which would be inexplicable were there no partial limitation of heredity by sex.

tastes, those who were fascinated by power, bodily or mental, and who married men able to protect them and their children, were more likely to survive in posterity than women to whom weaker men were pleasing, and whose children were both less efficiently guarded and less capable of self-preservation if they reached maturity. To this admiration for power, caused thus inevitably, is ascribable the fact sometimes commented upon as strange, that women will continue attached to men who use them ill, but whose brutality goes along with power, more than they will continue attached to weaker men who use them well. With this admiration of power, primarily having this function, there goes the admiration of power in general, which is more marked in women than in men, and shows itself both theologically and politically. That the emotion of awe aroused by contemplating whatever suggests transcendent force or capacity, which constitutes religious feeling, is strongest in women, is proved in many ways. We read that among the Greeks the women were more religiously excitable than the men. Sir Rutherford Alcock tells us of the Japanese that "in the temples it is very rare to see any congregation except women and children; the men, at any time, are very few, and those generally of the lower classes." Of the pilgrims to the temple of Juggernaut, it is stated that "at least five-sixths, and often nine-tenths, of them are females." And we are also told of the Sikhs, that the women believe in more gods than the men do. Which facts, coming from different races and times, sufficiently show us that the like fact, familiar to us in Roman Catholic countries, and to some extent at home, is not, as many think, due to the education of women, but has a deeper cause in natural character. And to this same cause is in like manner to be ascribed the greater respect felt by women for all embodiments and symbols of authority, governmental and social.

Thus the *a priori* inference, that fitness for their respective parental functions implies mental differences between the sexes, as it implies bodily differences, is justified; as is also the kindred inference that secondary differences are necessitated by their relations to one another. Those unlikenesses of mind between men and women, which, under the conditions, were to be expected, are the unlikenesses we actually find. That they are fixed in degree, by no means follows: indeed, the contrary follows. Determined as we see they some of them are by adaptation of primitive women's natures to the natures of primitive men, it is inferable that as civilization readjusts men's natures to higher social requirements, there goes on a corresponding readjustment between the natures of men and women, tending in sundry respects to diminish their differences. Especially may we anticipate that those mental peculiarities developed in women, as aids to defense against men in barbarous times, will diminish. It is probable, too, that, though all kinds of power will continue to be attractive to them, the attractiveness of physical strength and the mental attributes that commonly go along with it will decline, while the attributes which

conduce to social influence will become more attractive. Further, it is to be anticipated that the higher culture of women, carried on within such limits as shall not unduly tax the *physique* (and here, by higher culture, I do not mean mere language-learning and an extension of the detestable cramming-system at present in use), will in other ways reduce the contrast. Slowly leading to the result everywhere seen throughout the organic world, of a self-preserving power inversely proportionate to the race-preserving power, it will entail a less early arrest of individual evolution, and a diminution of those mental differences between men and women which the early arrest produces.

Admitting such to be changes which the future will probably see wrought out, we have meanwhile to bear in mind these traits of intellect and feeling which distinguish women, and to take note of them as factors in social phenomena—much more important factors than we commonly suppose. Considering them in the above order, we may note, first, that the love of the helpless, which in her maternal capacity woman displays in a more special form than man, inevitably affects all her thoughts and sentiments; and, this being joined in her with a less developed sentiment of abstract justice, she responds more readily when appeals to pity are made than when appeals are made to equity. In foregoing chapters we have seen how much our social policy disregards the claims of individuals to whatever their efforts purchase, so long as no obvious misery is brought on them by the disregard; but, when individuals suffer in ways conspicuous enough to excite commiseration, they get aid, and often as much aid if their sufferings are caused by themselves as if they are caused by others—often greater aid, indeed. This social policy, to which men tend in an injurious degree, women tend to still more. The maternal instinct delights in yielding benefits apart from deserts; and, being partially excited by whatever shows a feebleness that appeals for help (supposing antagonism has not been aroused), carries into social action this preference of generosity to justice, even more than men do. A further tendency, having the same general direction, results from the aptitude which the feminine intellect has to dwell on the concrete and proximate rather than on the abstract and remote. The representative faculty in women deals quickly and clearly with the personal, the special, and the immediate; but less readily grasps the general and the impersonal. A vivid imagination of simple direct consequences mostly shuts out from her mind the imagination of consequences that are complex and indirect. The respective behaviors of mothers and fathers to children sufficiently exemplify this difference: mothers thinking chiefly of present effects on the conduct of children, and regarding less the distant effects on their characters; while fathers often repress the promptings of their sympathies with a view to ultimate benefits. And this difference between their ways of estimating consequences, affecting their judgments on social affairs as on

domestic affairs, makes women err still more than men do in seeking what seems an immediate public good without thought of distant public evils. Once more, we have in women the predominant awe of power and authority, swaying their ideas and sentiments about all institutions. This tends toward the strengthening of governments, political and ecclesiastical. Faith in whatever presents itself with imposing accompaniments is, for the reason above assigned, especially strong in women. Doubt, or criticism, or calling in question of things that are established, is rare among them. Hence in public affairs their influence goes toward the maintenance of controlling agencies, and does not resist the extension of such agencies; rather, in pursuit of immediate promised benefits, it urges on that extension; since the concrete good in view excludes from their thoughts the remote evils of multiplied restraints. Reverencing power more than men do, women, by implication, respect freedom less—freedom, that is, not of the nominal kind, but of that real kind which consists in the ability of each to carry on his own life without hindrance from others, so long as he does not hinder them.

As factors in social phenomena, these distinctive mental traits of women have ever to be remembered. Women have in all times played a part, and, in modern days, a very notable part, in determining social arrangements. They act both directly and indirectly. Directly, they take a large, if not the larger, share in that ceremonial government which supplements the political and ecclesiastical governments; and as supporters of these other governments, especially the ecclesiastical, their direct aid is by no means unimportant. Indirectly, they act by modifying the opinions and sentiments of men—first, in education, when the expression of maternal thoughts and feelings affects the thoughts and feelings of boys, and afterward in domestic and social intercourse, during which the feminine sentiments sway men's public acts, both consciously and unconsciously. Whether it is desirable that the share already taken by women in determining social arrangements and actions should be increased, is a question we will leave undiscussed. Here I am concerned merely to point out that, in the course of a psychological preparation for the study of Sociology, we must include the comparative psychology of the sexes; so that, if any change is made, we may make it knowing what we are doing.

Assent to the general proposition set forth in this chapter does not depend on assent to the particular propositions unfolded in illustrating it. Those who, while pressing forward education, are so certain they know what good education is, that, in an essentially Papal spirit, they wish to force children through their existing school-courses under penalty on parents who resist, will not have their views modified by what has been said. I do not look, either, for any appre-

ciable effect on those who shut out from consideration the reactive influence on moral nature, entailed by the action of a system of intellectual culture which habituates parents to make the public responsible for their children's minds. Nor do I think it likely that many of those who wish to change fundamentally the political *status* of women will be influenced by the considerations above set forth on the comparative psychology of the sexes. But, without acceptance of these illustrative conclusions, there may be acceptance of the general conclusion, that psychological truths underlie sociological truths, and must therefore be sought by the sociologist. For whether discipline of the intellect does or does not change the emotions; whether national character is or is not progressively adapted to social conditions; whether the minds of men and women are or are not alike—are obviously psychological questions; and either answer to any one of them implies a psychological conclusion. Hence, whoever, on any of these questions, has a conviction to which he would give legislative expression, is basing a sociological belief upon a psychological belief; and cannot deny that the one is true only if the other is true. Having admitted this, he must admit that without preparation in Mental Science there can be no Social Science. For, otherwise, he must assert that the randomly-made and carelessly-grouped observations on Mind, common to all people, are better as guides than observations cautiously collected, critically examined, and generalized in a systematic way.

No one, indeed, who is once led to dwell on the matter, can fail to see how absurd is the supposition that there can be a rational interpretation of men's combined actions, without a previous rational interpretation of those thoughts and feelings by which their individual actions are prompted. Nothing comes out of a society but what originates in the motive of an individual, or in the united similar motives of many individuals, or in the conflict of the united similar motives of some having certain interests with the diverse motives of others whose interests are different. Always the power which initiates a change is feeling, separate or aggregated, guided to its ends by intellect; and not even an approach to an explanation of social phenomena can be made, without the thoughts and sentiments of citizens being recognized as factors. How, then, can there be a true account of social actions without a true account of these thoughts and sentiments? Manifestly, those who ignore Psychology as a preparation for Sociology, can defend their position only by proving that while other groups of phenomena require special study, the phenomena of Mind, in all their variety and intricacy, are best understood without special study; and that knowledge of human nature gained hap-hazard becomes obscure and misleading in proportion as there is added to it knowledge deliberately sought and carefully put together.

THE RINGED PLANET.

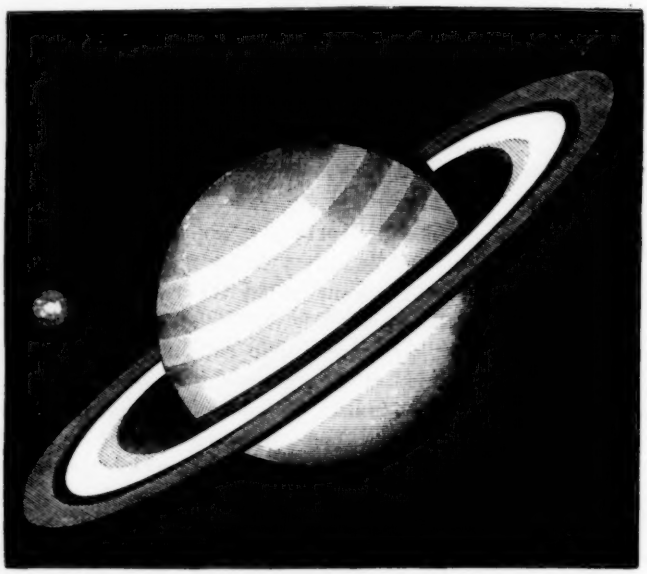
DURING the months of September, October, and November, Mars and Saturn are companions as evening-stars. It will not be difficult to recognize them, though the ruddy glories of Mars have been greatly reduced since July and August, when he shared with Jupiter the dominion over the western skies after sunset. The dull-yellow lustre of Saturn differs markedly from the red but more star-like light of Mars; and, as the two planets draw near to each other late in November (making their nearest approach on the 20th), it will be interesting to observe the contrast between the red and yellow planets of the solar system. Striking, however, as this contrast will be found to be, it is insignificant compared with the real contrast which exists between the two planets. Mars is the least but one of the primary members of the solar family, and, although he pursues a course outside the earth's, he is unlike all the other superior planets in being unaccompanied by any moon; his small orb, also, appears to have but a shallow atmospheric envelope, while in physical constitution he apparently occupies a position between the earth and the moon. Saturn, on the other hand, is inferior only to Jupiter in dimensions and mass, while he is superior to Jupiter not only in the astronomical sense that he travels on a wider orbit, but in the extent and importance of the scheme over which he bears sway; his orb, moreover, like that of Jupiter, appears to be the scene of marvelous processes of change, implying a condition altogether unlike that of the earth on which we live.

We propose to give a brief sketch of what has been ascertained respecting this wonderful planet, the most beautiful telescopic object in the whole heavens, and the one which throws the clearest light upon the nature of the solar system, and particularly of those giant planets which circle outside the zone of asteroids.

We would at the outset impress upon the reader the necessity of raising his thoughts above those feeble conceptions respecting Saturn and his system which are suggested by the ordinary pictures of the planet. When we see Saturn presented as a ball within a ring, or more carefully pictured as a striped globe within a system of rings, we are apt to regard the ideas suggested by such drawings as affording a true estimate of the planet's nature. In fact, many believe that the planet and its rings are really like what is presented in these pictures. It should be understood that what has been actually seen of Saturn by telescopic means cannot, in the nature of things, afford any true picture of the planet and its ring system. The picture must be filled in, not by the imagination, but by the aid of reason; and then, though much will still remain unknown, we shall have at least a far juster conception of the glories of the ringed world than when we simply

contemplate drawings which show how the planet looks under telescopic scrutiny. This will at once appear when we consider that Saturn never lies at a less distance than 732,000,000 miles from the earth. With the most powerful telescope we see him no better (taking atmospheric effects into account) than we should if this distance were reduced to about a million miles. It is manifest that at this enormous distance all save the general features of his globe and of his rings must be indistinguishable. Where we seem to see a smooth, solid globe striped with belts, there may be an orb no part of which is solid,

FIG. 1.



TELESCOPIC ASPECT OF SATURN, AND SIZE COMPARED WITH THE EARTH.

girt round by masses of matter lying many miles above its seeming surface. Where we seem to see solid, flat rings, neatly divided one from the other either by dark spaces or by difference of tint, there may be no continuous rings at all; the apparent spaces may be no real gaps; the difference of tint may imply no difference of material. On these and other points, the known facts afford important evidence, and, by reasoning upon them, we are carried far beyond the results directly conveyed to us by telescopic researches.

Saturn is distinguished, in the first place, by the enormous range of his orbit, not merely in distance from the sun, but in the distances which separate it from the orbits of his neighbor planets. His mean distance from the sun is about 872,000,000 miles, his actual range of distance lying between 921,000,000 and 823,000,000. These figures are imposing, but they are, in fact, meaningless save by comparison with

other distances of the same class. Let it be noticed, then, that Saturn's mean distance from the sun exceeds the earth's more than nine and a half times. Now, Jupiter's distance exceeds the earth's rather more than five times (five and a fifth is very nearly the true proportion); so that between Jupiter's path and Saturn's there lies everywhere a span fully equal to four times the earth's distance from the sun. So much for Saturn's nearest neighbor on that side. But on the farthest side lies Uranus, more than nineteen times as far away from the sun as our earth is; so that between the paths of Saturn and Uranus there lies everywhere a span equal to Saturn's own distance from the sun. Now, all this is not intended as a mere display of wonderful distances. So far as mere dimensions are concerned, these arrays of figures are more imposing than impressive. But, so soon as we take into account the circumstance that a planet is in some sense ruler over the spaces through which its course carries it, those spaces being by no means tenantless, we see that, *cæteris paribus*, the dignity of a planet is enhanced by the extent of the space separating its orbit from the orbits of its neighbors on either side. Now, the space between the paths of Saturn and Jupiter exceeds the space inclosed by the earth's orbit no less than 63 times, while the space between the paths of Saturn and Uranus exceeds the space inclosed by the earth's orbit 270 times! Assuming (as we seem compelled to do by continually-growing evidence) that Saturn and his system were formed by the gathering in of matter from the region over which Saturn now bears sway, we cannot wonder that the planet is a giant, and his system wonderful in extent and complexity of structure. It is true that Jupiter on one side, and Uranus on the other, share Saturn's rule over the vast space, 330 times the whole space circled round by the earth, which lies between the orbits of his neighbor planets. But Saturn's rule is almost supreme over the greater part of that enormous space. Combining the vastness of the space with its position—not so near to the sun that solar influence can greatly interfere with Saturn's, nor so far away as to approach the relatively-barren outskirts of the solar system—we seem to find a sufficient explanation of Saturn's *high* position in the scheme of the planets as respects volume and mass, and his *foremost* position as respects the complexity of the system over which he bears sway.

Briefly, then, to indicate his proportions, and the dimensions of his system:

Saturn has a globe considerably flattened, his equatorial diameter being about 70,000 miles, while his polar axis is nearly 7,000 miles shorter. Thus in volume he exceeds the earth nearly 700 times, and all the four terrestrial planets—Mercury, Venus, the Earth, and Mars—taken together, more than 336 times. In mass he does not exceed the earth and these other smaller planets so enormously, because his density (regarding him as a whole) is much less than the earth's. In fact, his density is less than that of any other known body (comets,

of course, excepted) in the solar system. The reader is doubtless aware that the sun's mean density is almost exactly one-fourth of the earth's; Jupiter's is almost exactly the same as the sun's; but Saturn's is little more than half the sun's, being represented by the number 13 only, where 100 represents the earth's. Thus, instead of exceeding the earth nearly 700 times in mass, as he would if he were of the same density, he exceeds her but about 90 times. But this disproportion must still be regarded as enormous, especially when it is added that the combined mass of the four terrestrial planets amounts to little more than the forty-fourth part of Saturn's mass. The combined mass of Uranus and Neptune, though these are members of the family of major planets, falls short of one-third of Saturn's mass; yet, by comparison with Jupiter, whose mass exceeds his more than threefold, Saturn appears almost dwarfed. And it may be noted as a striking circumstance—one that is not sufficiently recognized in our astronomical treatises—that, while Jupiter's mass exceeds the combined mass of all the other planets (including Saturn) about two and a half times, Saturn exceeds all the remaining planets in mass about two and three-quarter times. So unequally is the material of the planetary system distributed.

FIG. 2.

SATURN AND HIS MOONS.

The mighty globe of Saturn rotates on its axis in about nine hours and a half, the most rapid rotation in the solar system so far as is yet known.

But what shall we say to indicate adequately the dimensions of that enormous ring-system which circles around Saturn? Here we have no unit of comparison, and scarcely any mode of presenting the facts except the mere statement of numerical relations. Thus the full span of the rings, measured across the centre of the planet, amounts to 167,000 miles; the full breadth of the ring-system amounts to 35,600 miles. But these numbers convey only imperfect ideas. Perhaps the best way of indicating the enormous extent of the ring-system is to mention that circumnavigation of the world by a ship sailing from England to New Zealand by the Cape of Good Hope, and from New Zealand to England by Cape Horn, would have to be repeated 21 times to give a distance equaling the outer circumference of

the ring-system. The same double journey amounts in distance to but about two-thirds the breadth of the ring-system.

As to the scale on which Saturn's system of satellites is constructed, we shall merely remark that the span of the outermost satellite's orbit exceeds nearly twofold the complete span of the Jovian system of satellites, and exceeds the span of our moon's orbit nearly tenfold.

And now let us consider what is the probable nature of the vast orb which travels—girt round always by its mighty ring-system—at so enormous a distance from the sun that his disk has but the ninetieth part of the size of the solar disk we see. Have we in Saturn, as has been so long the ordinary teaching of astronomy, a world like our own, though larger—the abode of millions on millions of living creatures—or must we adopt a totally different view of the planet, regarding it as differing as much from our earth as our earth differs from the moon, or as Saturn and Jupiter differ from the sun?

We must confess that, if we set on one side altogether the ideas received from books on astronomy, endeavoring to view these questions independently of all preconceived opinions, it appears antecedently improbable that Saturn or Jupiter can resemble the earth either in attributes or purpose. We conceive that, if a being capable of traversing at will the interstellar spaces were to approach the neighborhood of our solar system, and to form his opinion respecting it from what he had observed in other parts of the sidereal universe, he would regard Jupiter and Saturn, the brother giants of our system, as resembling rather those companion orbs which are seen in the case of certain unequal double stars, than small dependent worlds like our earth and Venus. There are, perhaps, no instances known to our telescopists in which the disparity of *light*, as distinguished from real magnitude, is quite so great as that which exists in the case of the sun and the two chief planets of the solar system.[1] But we see in the heaven of the fixed stars all orders of disproportion between double stars, from the closest approach to equality down to such extreme inequality, that, while the larger star of the pair is one of the leading brilliants of the heavens, the smaller can only just be discerned with the largest telescopes yet made, used on the darkest and clearest nights. We have no

[1] Even this is not certain. Jupiter, seen in full illumination from a stand-point so distant that both Jupiter and the sun might be regarded as equally distant from it, would appear to shine with rather more than the 3,000th part of the sun's light. This would correspond to the difference of apparent brightness between two stars of equal real magnitude and splendor, whereof one was about 54 times as far away as the other. There can be no doubt that the larger reflectors of the Herschels, Rosse, and Lassell, and the great refractors of Greenwich, Pulkowa, and Cambridge (United States), would bring the farther of two such stars into view if the nearer were of the first or second magnitude; and it is not at all unlikely that some of the exceedingly minute companions to bright stars, disclosed by these instruments, may be planets shining with reflected, not with inherent lustre.

reason to believe that the series stops just where our power of tracing it ceases; on the contrary, since the series is continuous as far as it goes, and since our own solar system is constituted as if it belonged to the series prolonged far beyond the limits which telescopic scrutiny has reached, we have reason for believing that such is indeed the interpretation of the observed facts. In other words, we may not unreasonably regard our solar system as a multiple system, a double star at certain ranges of distance, whence only the sun and Jupiter could be seen; a triple star at distances whence Saturn could be seen; and a quintuple star where Uranus and Neptune would come into view. To show what excellent reason exists for regarding Mercury, Venus, the Earth, and Mars, as not to be included in this view, it is only necessary to remark that not one of these planets could be seen until the limits of the solar system had been crossed. To eyesight such as ours, not one of the four terrestrial planets could be seen from Saturn, and still less, of course, from Uranus or Neptune. It would be as unreasonable to hold the ring of asteroids, or even the myriads of systems of meteorolites and aërolites, to be bodies resembling the earth and her fellow-terrestrial planets, as it is to hold these terrestrial planets to be bodies resembling Jupiter and his fellow-giants.

In all characteristics yet recognized by astronomers, Jupiter and Saturn differ most markedly from the earth and her fellow-planets. In bulk and mass they belong manifestly to a different order of created things; in density they differ more from the earth than the sun does; they rotate much more swiftly on their axes; they receive much less light and heat from the sun; the lengths of their year exceed the length of the earth's year as remarkably as their day falls short of hers; the atmospheric envelope of each is divided into variable belts, utterly unlike any thing existing in the earth's atmosphere; and, lastly, each is the centre of an important subsidiary scheme of bodies quite unlike the moon (the only secondary planet in the terrestrial family) as respects their relations to the primary around which they travel.

Notwithstanding all these circumstances in evidence of utter dissimilarity, and the fact that not one circumstance in the condition of the major planets suggests resemblance to the terrestrial planets, astronomy continues to treat of the planets of the solar system as though they formed a single family. It would appear as though the teachings of the astronomers who lived before the telescope was invented had so strong an inherent vitality, that more than two centuries and a half of discoveries adverse to those teachings are powerless to dispossess them of their authority. For no other reason can be suggested, as it appears to me, for the complete disregard with which the most striking characteristics of the major planets have been treated by modern astronomers.

If we consider one feature alone of those which have been just

mentioned—the small mean density of the giant planets—we have at once the strongest possible evidence to show that the condition of these bodies must be unlike that of the earth. Of course, if we assume that Saturn's substance (to limit our attention to this planet) is composed of materials altogether unlike any which exist on earth, a way out of our difficulty is found, though not an easy one. In that case, however, we are only substituting one form of complete dissimilarity for another. And all the results of spectroscopic analysis, as applied to the celestial bodies, tend to show the improbability that such differences of elementary constitution exist—we will not say in the solar system only, but in the sidereal universe itself. If, however, we admit that Saturn is in the main constituted of elements such as we are familiar with, we find it extremely difficult, or rather it is absolutely impossible, to suppose that the condition of his substance is like that of the earth's. There are certain unmistakable facts to be accounted for. *There* is the mighty mass of Saturn, exceeding that of the earth ninety-fold. That mass is endued with gravitating energy, precisely in the same way as the earth's mass. There must be from the surface toward the centre a continually increasing pressure. This pressure is calculable,[1] and enormously exceeds the internal pressures existing within the earth's interior. There is no possibility of cavities, as Brewster and others have opined; for there is no known material, not the strongest known to us, iron, or platinum, or adamant, which could resist the pressures produced by Saturn's internal gravitation. Steel would be as yielding as water under these pressures. There must be compression with its consequent increase of density, such compression exceeding many million-fold the greatest with which terrestrial experimenters have dealt. That, with these enormous forces at work, the actual density of Saturn as a whole should be far less than that of water is utterly inexplicable, unless Saturn's *condition* be regarded as altogether unlike that of the earth. We see in the sun an orb which, notwithstanding its enormous mass, has a mean density much less than the earth's, and little greater than that of water; but we have no difficulty in understanding this circumstance, because we

[1] It is a misfortune for science that Newton never published the reasoning which led him to the conclusion that the earth's mean density is equal to between five and six times the density of water. This, as every one knows, has been confirmed by several experimental methods; and, so far as appears, the problem is a purely experimental one. Newton, however, made no experiments; at least, none have been heard of as effected by him, and it is scarcely probable that he had any instruments of sufficient delicacy for a task so difficult. Prof. Grant ascribes Newton's conclusion to a happy intuition; yet it is very unlike Newton to make a guess on such a matter. It is more probable that he guessed the elements of the problem than the result. He probably assumed that the earth's mass is composed of a substance like granite, and, adopting some law of compression for such a substance (based on experiment, perhaps), calculated thence the compression at different depths, and so obtained the mean destiny of the whole mass.

see that the sun is in a state of intense heat, and we know that this heat produces effects antagonistic, as it were, to those produced by the attraction of his mass as a whole upon every portion of his substance. But, if we make no similar assumption in Saturn's case, we find his small density inexplicable.

Another circumstance associated with the question of Saturn's density introduces new difficulties of the most perplexing nature if it be regarded according to the ordinary view, while it seems not only explicable, but manifestly to be expected, on the theory that Saturn's whole orb is in an intensely heated condition. Saturn certainly has an atmosphere of considerable depth. The belts which surround his globe are evidently produced by clouds in his atmosphere, though what the nature of these clouds may be is not as yet known. The brighter belts are the cloud-belts, while the darker either show his real surface, or, far more probably, belong simply to lower cloud-layers. These belts are variable in appearance and position, sometimes changing with great rapidity. Their real extent is enormous, exceeding the whole surface of our earth, even in the case of the narrowest belts yet seen. No one who has viewed them through telescopes of great power can refuse to adopt the conclusion that the atmosphere in which these great cloud-zones are suspended must be of great depth, certainly far deeper than our atmosphere. But such an atmosphere, subjected to the attractions of Saturn's mass, would be enormously compressed underneath those manifestly thick cloud-layers. A very moderate assumption as to the depth of the atmosphere would lead to the conclusion that at its base it must be denser than water—that is, denser than Saturn himself. No gas could exist *as* gas at this density. Apart from this, we are here arriving at the very theory which the ordinary view of Saturn teaches us to avoid—viz., the theory that he is utterly unlike our earth in physical condition. We may much more conveniently arrive at the same general conclusion, while avoiding other difficulties, by simply adopting the same explanation in this case which serves to account also for the small density of Saturn's mass—viz., the theory that Saturn's globe is in a state of intense heat.

But now let it be noticed how perfectly this view of Saturn's con dition accords with the theories which are beginning to be established respecting the genesis of the solar system. Whether we regard the planets as formed from the condensation of enormous nebulous masses, or whether we assume that they were produced by the gathering together of matter originally traveling in dense meteoric flights around the central aggregation whence the sun was one day to be formed, we see that the larger the planet the greater must have been its origiual heat. The heat generated during the condensation of a nebulous mass must depend upon the magnitude of the mass, since in fact the accepted theory of heat teaches us that the original heat of a globe so

formed is measurable by the actual difference in dimensions between the globe and its parent cloud-mass, and of course the larger the cloud-mass the greater this difference would necessarily be. It is equally certain that the heat generated by the gathering-in of meteoric matter would be so much the greater according as the quantity of matter gathered and gathering was greater; for the heat is produced by the downfall of such matter on the globe it helps to form, and the greater the mass of that globe the greater is its attracting might, the greater the velocity it generates in the falling meteors, and therefore the greater the heat produced when they are brought to rest.

Saturn, then, would originally be much hotter than our earth, on any theory of the *evolution* of our solar system—and there are few astronomers who doubt that the solar system *was* wrought by processes of evolution to its present condition. But not only would Saturn be much hotter than the earth, but, owing to his enormous size, he would part with his heat at a much slower rate. On both accounts we should infer that at this present time Saturn is much hotter than the earth—in other words, since our earth still retains no inconsiderable proportion of its original heat, Saturn may be assumed to be in a state of intense heat. What his actual heat may be is not so easily determined. We shall presently show reasons for believing that an inferior limit, below which his heat does not lie, is indicated by the fact that he still possesses inherent luminosity. On the other hand, a superior limit is indicated by the fact that his inherent luminosity is not great, and that, in all probability, the thicker cloud-zones of Saturn prevent the passage of the greater part of his light.[1]

We should infer, then, that Saturn in some respects resembles the sun, though of course the very same reasoning which teaches us to believe that Saturn is very much hotter than the earth, leads us also to the conclusion that it is not nearly so hot as the sun. Now, thus viewing Saturn, we should be led to expect, apart from all telescopic evidence to that effect, that he would resemble the sun in certain general features. For instance, we might expect that he would have spot-zones, while his equatorial zone would be free from spots; or, if it were thought that so close a resemblance was not to be looked for, then we might still expect that his equatorial zone, like the sun's, would be distinguished from the rest of his surface by some well-marked peculiarity. This is the case. The equatorial zone of Saturn is distinguished by a peculiar brightness from the rest of his surface, insomuch that the late Prof. Nichol was led to regard this zone as the

[1] To prevent misapprehension, it may be as well to remind the reader that the apparent continuity of Saturn's cloud-belts by no means implies that they are really continuous, and it is on *a priori* grounds highly improbable that they are so; openings in his cloud-zones two or three hundred miles in length and breadth would be quite undiscernible at Saturn's enormous distance.

scene of a constant precipitation of meteoric matter from the inside of the ring-system.

Now, there is one important peculiarity which distinguishes the equatorial bright zone of Saturn from that of Jupiter. Jupiter's axis is almost square to the level of the path in which he travels around the sun; so that his equatorial zone lies nearly in that level, and is therefore directly illuminated by the sun. The aspect of Jupiter in fact, as seen from the sun, is *always* that which our earth presents in spring and autumn. But Saturn has an axis very considerably sloped to the level of the path in which he travels. It is more sloped even than our earth's axis. So that in the course of his long year of 10,759 days (29½ of our years) Saturn's globe presents toward the sun all the varying aspects which our earth presents, only with a somewhat greater range of variation. At one time he is placed as our earth is in spring, and then his equatorial belt, as seen from the sun, appears to lie straight across the middle of his disk. Rather more than seven years later he is posed as our earth is posed at midsummer, his northern pole is bowed toward the sun, and his equator is seen as a half-oval, curving far south of the middle point of his disk. He passes on from this position, and in seven more years he is placed as our earth is in autumn, with his equator again lying straight across his disk. Then, seven years or so later, he presents the aspect of our earth at midwinter, his equator curved into a half-oval passing far to the north of the middle point of his disk. And, finally, at the end of yet seven years more (or, more exactly, of one complete Saturnian year from the commencement of these changes), he is again as at first. Now, it seems manifest that, if the great cloud-zone which surrounds Saturn, appearing as a nearly white ring, were due to solar action, it would fluctuate in position as these changes proceeded. The very length of the Saturnian year should insure the occurrence of such fluctuations. We have only to inquire what takes place on our own earth, where, though we have nothing comparable with the belt systems of Jupiter and Saturn, we have, nevertheless, over ocean-regions, a sun-raised tropical cloud-band in the middle of the day. This cloud-band *follows the sun*, being equatorial in spring, passing far north of the equator, even to the very limit of the torrid zone, in summer, returning to the equator in autumn, passing to the southern limit of the torrid zone in winter, and returning again to the equator in spring. In fact, this cloud-band as seen from the sun would always cross the middle of the earth's face as a straight line in spring and autumn, and as considerably more than a half-oval, agreeing in position with the tropics of Cancer and Capricorn, at midsummer and midwinter. But nothing of the sort happens in Saturn's case. His equatorial white ring is *really* equatorial at all times, instead of being drawn to his tropics at his midsummer and midwinter seasons. This, in our opinion, is decisive of the origin of this great band. If it were sun-raised, it would obey the sun; but, being raised

by Saturnian action, its position is solely determined by Saturn's rotation, and it therefore remains constantly equatorial.

But next a very strange and, at a first view, incredible circumstance has to be considered in immediate connection with the relations we have been dealing with.

It sounds startling to suggest that *Saturn probably changes at times in size and shape.* Yet the evidence in favor of the suggestion is very weighty. It may briefly be presented as follows:

In April, 1805, Sir William Herschel, *who had hitherto always seen the planet of an oval figure,* found that it presented a strangely distorted appearance. It was flattened as usual at the poles, but also at the equator; accordingly, it had a quadrangular or oblong figure (with rounded corners, of course), its longest diameters being the two which (crossing each other in the middle of the disk) passed from north latitude 43° on Saturn to the same southerly latitude. Or we may otherwise describe the appearances presented, by saying that Saturn seemed *swollen* in both the temperate zones. Herschel found that the same appearance was presented, no matter what telescope he employed, and he tried many, some seven feet, some ten, one twenty, and one forty feet in length. With these telescopes Jupiter presented his ordinary oval aspect. But Herschel is not the only astronomer by whom such appearances have been noticed. On August 5, 1805, Schröter found that Saturn's figure was distorted. Dr. Kitchener says that in the autumn of 1818 he found Saturn to have the figure described by Herschel. The present Astronomer Royal has seen Saturn similarly distorted, and on another occasion *flattened* in the temperate zones. In January, 1855, Coolidge, with the splendid refractor of the Cambridge (U. S.) Observatory noticed a swollen appearance in Saturnian latitude 20°; yet on the 9th the planet had resumed its usual aspect. In the report of the Greenwich Observatory for 1860–'61, it is stated that "Saturn has *sometimes* appeared to exhibit the *square-shouldered* aspect." The two Bonds, of America, surpassed by few in observing skill, have seen Saturn square-shouldered and have noticed variations of shape. It seems impossible to reject such testimony as this. Nor can it be disposed of by showing that ordinarily Saturn presents a perfectly elliptical figure. It is the essential point of the circumstances we are considering, that they are unusual.

Now, we do not pretend to explain how such changes of shape are brought about. But we would invite special attention to the circumstance that if these changes be admitted as having occasionally occurred (and we do not see how they can be called in question), then the result is only startling in connection with that theory of Saturn's condition which we are here opposing. If Saturn be a globe resembling our earth, then sinkings and upheavals, such as these appearances indicate, must be regarded as involving amazing and most stupendous throes—as in fact absolutely incredible, no matter what evidence may

be found in their favor. But, so soon as we regard Saturn's whole globe as in a state of intense heat, and his belt-system as indicating the continual action of forces of enormous activity, we no longer find any difficulty in understanding the possibility of changes such as Sir W. Herschel, Sir G. Airy, the Bonds, and others of like observing skill, have seen with some of the finest reflecting and refracting telescopes ever constructed by man. Nay, we may even go further, and find in solar phenomena certain reasons for believing that Saturn's globe would be subjected to precisely such changes. It appears to have been rendered extremely probable by Secchi and others, that our sun's globe varies in dimensions under the varying influences to which he is subjected. At the height of the spot-period the sun seems to be reduced in diameter, while his colored sierra is deeper, and the red prominences are larger than usual, the reverse holding at the time when the sun has no spots or few. Of course this is not understood as implying a real change in the quantity of solar matter, but only as indicating the varying level at which the solar cloud-envelope lies. We may safely assume that these changes, which correspond to the great spot-period, affect chiefly the spot-zones which lie in the parts of the sun's globe corresponding to our temperate zones; but, for the same reasons that the sun's globe is perfectly spherical so far as measurements can be depended upon, namely, because of its relatively slow rotation—such differences would be too slight to be measurable. Regarding Saturn, then, as we have already been compelled to do for other reasons, as resembling the sun so far that he is in an intensely heated condition, we see grounds for believing that *his* temperate zones would be exposed to variations of level (cloud-level), which at times might be very considerable, and thus discernible from our earth. For, owing to his rapid rotation on his axis, all such effects would be relatively greater than on a slowly rotating orb like the sun; and in fact we recognize this distinction in the great compression of Saturn's globe. Moreover, if we regard the waxing and waning of the solar spots as associated with the motions of the members of the sun's family, we can well understand that the members of Saturn's family, which lie so much nearer to him compared with his own dimensions, should produce more remarkable effects.[1] But, whether this be so or not, it is certain

[1] It must not be understood that in thus speaking we countenance the theory that either the planets produce the sun-spots, or the satellites of Saturn effect the remarkable changes we have been dealing with. The real causes of all solar phenomena must be sought in the sun's own globe; and Saturnian phenomena are in the main, we have little doubt, produced by Saturnian action. But even as our moon (probably) exerts an influence on the occurrence of earthquakes and volcanoes, *not* by her own attraction directly, but by affecting the balance between terrestrial forces, so it may well be that the planets indirectly affect the sun's condition, and that the Saturnian satellites even more effectually act upon Saturn. It would be extremely interesting to inquire whether any connection can be traced between the changes of the Saturnian belts and the motions of his satellites. Or the inquiry might be more readily and quite as effectually applied to Jupiter and his system.

that, whereas there is nothing inexplicable or even very surprising in supposing that Saturnian cloud-layers, resulting from the action of intense Saturnian heat, alter greatly at times in level, the observations we have described become altogether inexplicable, and cannot, in fact, be rejected, if we adopt the theory that Saturn resembles the earth on which we live.

It may be asked whether Jupiter, to which planet the same reasoning may be applied, has ever shown signs of similar changes. To this it may first be replied, that we should not expect Jupiter to be affected to the same degree, simply because the chief disturbing causes—his satellites and the sun—are always nearly in the same level, owing to the peculiarity in Jupiter's pose to which attention has already been directed. But, secondly, such briefly-lasting changes as we might expect to detect have occasionally been suspected by observers of considerable skill; and among others by the well-known Schröter, of Lilienthal. Such changes have consisted, for the most part, merely in a slight flattening of a part of Jupiter's outline. But on one occasion a very remarkable phenomenon, only (but very readily) explicable in this way, was witnessed by three practised observers—Admiral Smyth, Prof. Pearson, and Sir T. Maclear—at three different stations. Admiral Smyth thus describes what he saw: "On Thursday, June 26, 1828, the evening being extremely fine, I was watching the second satellite of Jupiter as it gradually approached to transit Jupiter's disk. It appeared in contact at about half-past ten, and for some minutes remained on the edge of the disk, presenting an appearance not unlike that of the lunar mountains coming into view during the moon's first quarter, until it finally disappeared on the body of the planet. At least twelve or thirteen minutes must have elapsed, when, accidentally turning to Jupiter again, to my astonishment I perceived the same satellite *outside the disk!* It remained distinctly visible for at least four minutes, and then suddenly vanished!" For our own part, we can conceive of no possible explanation of this remarkable phenomenon, unless it be admitted that the change was in the apparent outline of Jupiter. Of course, to suppose that even a cloud-layer rose or fell, in a few minutes, several thousand miles (about 8,000, if the stated times be correct), is as inadmissible as to suppose the solid crust of a globe to undergo so vast a change of level; but nothing of this sensational description is required. All that would be necessary would be, that an upper cloud-layer should for a few minutes be dissipated into vapor, either by warm currents, or more probably by a temporary increase of the heat supplied by Jupiter's fiery globe within the cloud-envelopes, and that a few minutes later the clouds should form again by the condensation of the vaporized matter. The changes in the aspect of the Jovian belts are often sufficiently rapid to indicate the operation of precisely such processes.

Associated with such phenomena as we have mentioned is the evi-

dence we have as to the brightness of Saturn and Jupiter. If these planets were perfectly cloud-encompassed, we should expect them to shine much more brightly than earthy or rocky globes of equal size, similarly placed, and surrounded only with a tenuous atmosphere. In fact, we should expect the planets, if cloud-encompassed, to shine about four times as brightly as though they were constituted like our moon. They would in that case, however, be white planets, not only as seen by the naked eye, but when examined with the telescope. In point of fact, they shine, according to the very careful measurements of Zöllner, about as brightly as though they *were* perfectly cloud-enveloped; but they are neither of them found to be white under telescopic scrutiny. Bond, of America, says, indeed, that Jupiter shines *fourteen* times as brightly as he would if constituted like the moon; and though this is a surprising result, and would imply that some portion of Jupiter's light is certainly inherent, it is well to notice that it is confirmed by De La Rue's photographic researches; for he found that a photographic image of the moon can be taken in about two-thirds of the time required in Jupiter's case, whereas the moon should require but a twenty-fifth of the time required by Jupiter, if her reflecting power were equal to his, since Jupiter is five times as far away from the sun. It would follow from this that Jupiter shines nearly seventeen times as brightly as he would if he were constituted like the moon. Taking the lowest estimate, however, we find that both Saturn and Jupiter shine much more brightly than planets of equal size and similarly placed, but having a surface formed of any kind of earth or rock known to us. And, taking into account the well-marked colors of these planets, it follows as an almost demonstrated fact that each shines with no inconsiderable portion of inherent light.[1]

So soon as we view Saturn as a globe intensely heated, and the scene of forces of enormous energy, we are compelled to dismiss the idea that he is the abode of life. But, singularly enough, this conclusion, which was rejected by Brewster as rendering apparently unintelligible the existence of so large and massive an orb, girt about by a system so complex and beautiful, does in reality at once present, in an explicable aspect, not merely the vast bulk of Saturn himself, but the scheme over which he bears sway; for, as it seems to us, not the least of the objections against the theory that Saturn is an inhabited world, is found in the useless wealth of material exhibited, on that

[1] I might take, as equally convincing proof of the intensely heated condition of these giant planets, the fact that the shadows of the nearer satellites, which theoretically should be black, have *sometimes* been seen to be gray, and never appear to be much darker than the fourth satellite in transit. And, as sufficient proof of the great depth of Jupiter's atmosphere, I could take the fact that sometimes two shadows have been seen, both belonging to the same satellite. However, it would require more space than can here be spared to show the force of these facts. I remind the reader that whatever is proved respecting the condition of Jupiter, may be regarded as rendered probable of his brother giant, Saturn.

supposition, in his ring-system and family of satellites. It is very well to grow rapturous, as many besides Brewster and Chalmers have done, over the beauty of the Saturnian skies, illuminated by so many satellites and by the glorious rings; and it is very proper, no doubt, for those who so view Saturn's system, to dwell admiringly on the beneficence with which all this abundance of reflected light has been provided, to make up to the Saturnians for the small amount of light and heat which they receive from the sun. But, unfortunately for this way of viewing the matter, the satellites and rings do not by any means subserve the purposes thus ascribed to them. Even if all the satellites could be full together, they would not supply a sixteenth part of the light which we receive from our full moon; and they cannot even appear very beautiful when we consider that the apparent brightness of their surface can be but about one-ninetieth of the brightness of our moon's. As for the rings, so far from appearing to be contrived specially for the advantage of Saturnian beings, these rings, if Saturn *were* inhabited, would be the most mischievous and inconvenient appendages possible. They would give light during the summer nights, indeed, when light was little wanted, though even this service would be counteracted by the circumstance that at midnight the enormous shadow of the planet would hide the greater part of the rings. But it is in winter that the rings would act most inconveniently; for then, just at the season when the Saturnians would most require an additional supply of light and heat, the rings would cut off for extensive regions on Saturn the whole of the solar light and heat which would otherwise be received. Dr. Lardner was quite mistaken in supposing (after a cursory examination of the mathematical relations involved) that the eclipses so produced would be but partial. His object was excellent, since he sought to show that "the infinite skill of the Great Architect of the universe has not permitted that the stupendous annular appendage, the uses of which still remain undiscovered, should be the cause of such darkness and desolation to the inhabitants of the planet, and such an aggravation of the rigors of their fifteen years' winter," as would result from eclipses lasting many months or even years in succession. But we must not endeavor to strengthen faith in the wisdom of the Almighty by means of false mathematics. So soon as the subject is rigorously treated, we find that Sir John Herschel was quite right in his original statements on this subject. The present writer published, in 1865, a tabular statement of the length of time during which (according to rigid mathematical calculations) the eclipses produced by the rings last in different Saturnian latitudes. The following quotation from the work in which this table appeared will serve to show that the partial daily eclipses conceived by Lardner are very far from the truth, or rather are only a part, and a very small part, of the truth: "In latitude 40° (north or south), the eclipses begin when nearly three

years have elapsed from the time of the autumnal equinox. The morning and evening eclipses continue for more than a year, gradually extending until the sun is eclipsed during the whole day. These total eclipses continue to the winter solstice, and for a corresponding period after the winter solstice; in all, for six years, 236 days, or 5,543 Saturnian days. This period is followed by more than a year of morning and evening eclipses. The total period during which eclipses of one kind or another take place is no less than eight years, 293 days. If we remember that latitude 40° on Saturn corresponds with the latitude of Madrid on our earth, it will be seen how largely the rings must influence the conditions of habitability of Saturn's globe, considered with reference to the wants of beings constituted like the inhabitants of our earth."[1] In the presence of such facts as these, we may follow Sir John Herschel in saying that "we should do wrong to judge of the fitness or unfitness of the arrangements described, from what we see around us, when perhaps the very combinations which convey to our minds only images of horror may be in reality theatres of the most striking and glorious displays of beneficent contrivance." But we do well to exercise our minds in inquiring how this may be; and, as it appears to us, the views which have been advocated in this essay at once afford an answer to this inquiry. We are taught to see in the Saturnian satellites a family of worlds dependent on him, in the same way that the members of the solar family are dependent on the sun. We see that, though the satellites can supply Saturn with very little light, he can supply them, whether by reflection or by inherent luminosity, with much. And, lastly, we see that the ring-system (which has been shown to consist of a multitude of small bodies, each traveling in its own course), while causing no inconvenience by eclipsing parts of Saturn, may not improbably serve highly-important purposes by maintaining an incessant downfall of meteoric matter upon his surface, and thus sustaining the Saturnian heat, in a manner not unlike that in which it is now generally believed that a portion at least of the sun's heat-supply is maintained by the fall of interplanetary meteors. In fine, we see in Saturn and his system a miniature, and a singularly truthful miniature, of the solar system. In one system, as in the other, there is a central orb, far surpassing all the members of the system in bulk and mass; in each system there are eight orbs circling around the central body; and, lastly, each system exhibits, close by the central orb, a multitude of discrete bodies—the zodiacal light in the solar system, and the scheme of rings in the Saturnian system—doubtless subserving important though as yet unexplained purposes in the economy of the systems to which they belong.—*Cornhill Magazine.*

[1] As this passage has been quoted nearly *verbatim*, and without any sort of acknowledgment, in a compilation on "Elementary Astronomy," recently published, the present writer, that he may not be suspected of plagiarism, ventures to point out that it is not he who is the borrower.

THE PHENOMENA OF HEREDITY.

By FERNAND PAPILLON.

TRANSLATED BY J. FITZGERALD, A. M.

IN human science there is many a ground of self-satisfaction and of pride for the mind, but there are at the same time reasons for humility and bitter disappointment. Notwithstanding the strenuous efforts and the protracted meditations of the legions of investigators who have gone before us, Nature still has abysses dark and deep before which the keenest sight becomes blindness, courage changes into fear, and assurance into despondency. When we strive to throw some light into these mysterious gulfs, the light does but reveal to us the spectres of our own ignorance, and all that we carry away from the vain attempt is a renewed consciousness of our weakness and indigence. It were wise for us to carry away something more, viz., a useful lesson. Indeed, there is nothing that is better fitted to teach us modesty and patience, to cool down presumptuous ardor, and to put to shame overweening temerity, than the study of those phenomena which Providence would seem to have devised for the express purpose of baffling man's curiosity. And yet many there are who pretend to ignore the wonderful and complex phenomena which occur in regions inaccessible to sight or sense, and who stubbornly question the existence of invisible activities and insensible forces. Such is the fatal skepticism against which we must cite the testimony of the sphinxes that occupy our attention now. The lesson is all the more impressive, inasmuch as, by strange contrast, these questions, so refractory to all manner of theoretic explanation, are precisely the ones with which our empirical acquaintance is fullest. Here a knowledge of effects seems in no wise to pave the way to a knowledge of causes.

These remarks have a special application to the subject of heredity. It is an ascertained fact that the ovum contains in its seemingly homogeneous substance not only the anatomical structure of the individual that is to spring from it, but also his temperament, character, aptitudes, sentiments, and thoughts. The parents place in this molecule the future of an existence which is nearly always the counterpart of themselves physiologically, oftentimes pathologically, and in many instances psychologically. Such are the results of the latest studies into this amazing vital economy; and these we purpose laying before our readers.

Heredity is that biological law in virtue of which living beings tend to transmit to their descendants a certain number of their own characteristic traits. It is a very nice question to decide whether we must class under heredity the transmission of the anatomical forms

and physiological functions which constitute the species. At all events, it is plain that in this case the parents are completely and absolutely repeated in the children. Were this not so, there would be no species, but only successions of beings without any relations between them save that of generation. Within the historic limits of experience, the continuous reproduction of specific characters, always identical, or, in other words, the permanent integrity of species, is a fact almost beyond question. The distinctive characters of races and of varieties are transmitted with less regularity and fixity, and it is precisely on the various transformations that these may undergo from one generation to another that a famous school of naturalists rest when they would prove, in a more or less extended sense, the transformation of organisms in time. But more irregular still and more variable is the repetition of those characters which, as being less general than those of a species or a race, may be regarded as belonging to the individual. Thus, in proportion as the characters become more particular and more special, the more are they released from the law of heredity, and the greater is the probability that the children will differ from the parents. Still, observation—an observation as ancient as the human race itself—shows that these characters, though personal, may be transmitted by generation. But within what limits, and under what conditions? This we have to inquire into with all circumspection, for there is no other subject in which one is so much in danger of making missteps, and of slipping on dangerous inclines.

Heredity is especially noticeable in the continuity of physiological and pathological conditions. It is very clearly evident in the expression and features of the physiognomy. This was observed by the ancients; hence the Romans had their Nasones, Labeones, Buccones, Capitones, etc. (*Big-nosed, Thick-lipped, Swollen-cheeked, Big-headed*). Of all the features, probably the nose is best preserved by heredity: the Bourbon nose is famous. Heredity also manifests itself by fecundity and longevity. In the old French noblesse there were several families which possessed high procreative vigor. Anne de Montmorency, who, at the age of over sixty-five years, could still, at the battle of St. Denis, smash with his sword the teeth of a Scotch soldier who was giving him the death-blow, was the father of twelve children. Three of his ancestors, Matthew I., Matthew II., and Matthew III., taken all together, had eighteen, and of these fifteen were boys. The son and grandson of the great Condé had nineteen between them, and their great-grandfather, who lost his life at Jarnac, had ten. The first four Guises reckoned in all forty-three children, of whom thirty were boys. Achille de Harley had nine children, his father ten, and his great-grandfather eighteen. In some families this fecundity endured through five or six generations. The average length of life depends on locality, diet, stage of civilization, but individual longevity appears

to be completely freed from these conditions. It is observed among those who lead the most laborious lives, as well as among those who take the greatest care of their health, and it seems to be connected with some inner power of vitality transmitted to individuals from their forefathers. So well known is this fact that, in England, life-assurance companies receive from their agents statements as to the longevity of the applicants' ancestors. In Turgot's family, the age of fifty-nine was very rarely exceeded, and the man who made that family illustrious had a presentiment, so soon as he had reached fifty, that the close of his life was not distant. Albeit he had all the appearances of good health and of great vigor of temperament, still from that time forward he held himself ready for death, and, in fact, did die at the age of fifty-three.

Heredity often transmits muscular strength and sundry other motor activities. In ancient times there were families of athletes, and the English have families of boxers. The recent researches of Mr. Galton, as to wrestlers and oarsmen, show that the winners in the contests in which these men engage generally belong to a few families in which agility and dexterity are hereditary. Suppleness and grace in dancing are also transmitted, as is shown in the case of the celebrated Vestris family. The same is to be said with regard to various peculiarities of voice, such as stammering, nasality, and lisping. There are several families who are naturally singers. Children born of babbling parents are themselves babblers by birthright. Dr. Lucas cites the case of a servant-maid whose loquacity knew no bounds. She would talk to people till they were ready to faint; but she would also talk to animals and to inanimate things. Even when she was quite alone she talked to herself aloud. She had to be discharged; "but," said she to her master, "I am not to blame; it all comes from my father. He had the same fault, and it drove my mother to distraction; and his father was just as I am."

The heredity of anomalies of organization has been demonstrated in several instances. One of the most singular of these is the case of Edward Lambert, whose whole body, except the face, the palms of the hands, and the soles of the feet, was covered with a sort of shell, consisting of horny excrescences. He was the father of six children, all of whom presented the same anomaly at the age of six weeks. The only one of them who lived transmitted the peculiarity to all his sons, and this transmission, passing from male to male, persisted through five generations. Mention is also made of the Colburn family, where the parents for four generations transmitted to the children what is called sexdigitism, i. e., hands and feet with six digits each. Albinism, halting, hare-lip, and other anomalies, are in like manner reproduced in the progeny. It has been observed that purely individual habits have a like tendency to repeat themselves. Girou de Buzareingues informs us that he knew a man who, when abed, was wont to lie on his back

with the right leg crossed on the left. One of his daughters had the same habit from birth; she constantly assumed that position in the cradle, notwithstanding the resistance offered by the swaddling-bands. The same author assures us that he has oftentimes noticed in children other habits no less extraordinary, which they must have received from their parents, and which cannot be attributed either to imitation or to education. Darwin gives another instance: A child had the odd habit of setting its fingers in rapid motion whenever it was particularly pleased with any thing. When greatly excited, the same child would raise the hands on both sides as high as the eyes, with the fingers in rapid motion, as before. Even in old age he experienced a difficulty in refraining from these gestures. He had eight children, one of whom, a little girl, when four years of age, used to set her fingers going and to lift up her hands after the manner of her father. Finally, heredity has been observed in handwriting. There are families in which the special use of the left hand is hereditary. Various peculiarities of sensorial conditions are transmitted in a similar way. Nearly all the members of the Montmorency family were affected with an incomplete strabismus, which used to be called the Montmorency look. The incapacity to distinguish between different colors is notoriously hereditary. The distinguished English chemist, Dalton, and two of his brothers, were thus affected, and hence the affection itself received the name of Daltonism. Deafness and blindness are sometimes hereditary, though not often, and deaf-muteness still more rarely. Some curious instances are given of the transmission of certain perverse tastes. Lucas, according to Zimmermann, relates the following: A man in Scotland was possessed of an irresistible desire of eating human flesh. He had a daughter. Although removed away from her father and mother, who were sent to the stake before she was one year old, and although brought up among respectable people, this girl, like her father, succumbed before her strange craving for human flesh. This is clearly a case allied to insanity.

Insanity is, beyond all doubt, transmitted by heredity. Among 1,375 lunatics Esquirol found 337 cases of hereditary transmission. Guislain and other physicians, on a rough estimate, represent the patients affected with hereditary insanity as one-fourth of the total number of the insane. Moreau, of Tours, and others, hold that the proportion of the former is still greater. The heredity of insanity does not imply merely direct transmission of insanity (alienation), properly so called; hysteria, epilepsy, chorea, idiocy, hypochondria, may result from insanity, and, *vice versa*, they may produce insanity. In passing from one generation to another, these various neuroses (nervous affections) are in some way transformed into one another.[1] Herpin, of Ge-

[1] Simple alcoholic intoxication may pass into profound neuroses. Children conceived during an acute attack of intoxication are often epileptic, insane, idiots, etc. These facts were observed long ago. A law of Carthage forbade all beverages except water on the

neva, has found, in the ancestry of 243 epileptics, seven epileptics, 21 insane, and 27 individuals who had suffered from cerebro-spinal affections. Georget, from numerous observations made at the Salpêtrière, came to the conclusion that hysterical women have always near relations who are hysterical, epileptical, hypochondriac, or insane. Moreau calls attention to the "prodigious quantity" of morbid nervous conditions to be found in the ancestry of idiots and imbeciles. A single fact will give the means of judging of the varied and odd complications occurring in the hereditary transmission of neuroses. Dr. Morel attended four brothers belonging to one family. The grandfather of these children had died insane, their father had never been able to continue long at any thing, their uncle, a man of great intellect, and a distinguished physician, was noted for his eccentricities. Now, these four children, sprung from one stock, presented very different forms of physical disorder. One of them was a maniac, whose wild paroxysms recurred periodically; the disorder of the second was melancholy madness; he was reduced by his stupor to a merely automatic condition. The third was characterized by an extreme irascibility and suicidal disposition. The fourth manifested a strong liking for art, but he was of a timorous and suspecting nature.

Scrofula, cancer, tubercular consumption, syphilis, gout, arthritis, tetter, and, in general, all those chronic constitutional affections which are called diatheses or cachexias, are very often transmitted from parent to child. The heredity of these morbid states is almost as frequent and as well defined as that of the neuroses. We may also affirm the heredity of skin-diseases, and especially of psoriasis, although in this case heredity is of rarer occurrence.

The evolution of these hereditary maladies is extremely interesting and dramatic. Planted in the children's system as germs, or as mere predispositions, they are sometimes destroyed, beyond the possibility of returning, by a multitude of favorable conditions and precautions: in other instances, they begin at once their fatal work of destruction; or, again, they lie hidden for years, reappearing at length, remorseless and terrible, under the influence of sundry exciting causes. Thus age, sex, temperament, practices, habits, hygiene, surrounding conditions, act a part in the development of hereditary morbid activities. Insanity is rare in childhood, and epilepsy most commonly makes its appearance in youth. Hysteria, scrofula, rachitism, and tubercle, appear in childhood and in youth, while gout, gravel, calculus, alopecia, and cancer, are hereditary states of the adult. Women are more liable to insanity, epilepsy, and hysteria, than men; but men, on the other hand, are far oftener than women attacked by gout, gravel, and calculus. The ner-

day of marital cohabitation, and Amyot says that "drunkenness genders naught that is sound." Recent accurate observations have shown that the child that is conceived in a fit of alcoholic delirium, though the latter be only transitory, carries forever the ineffaceable marks of a more or less profound degeneracy.

vous temperament favors neuroses; the lymphatico-sanguine, arthritis and tetter; and the lymphatic, scrofula. The changes occurring in the physiological equilibrium of an individual have a very definite action on the movements and aspects of constitutional affections. Thus, insanity oftentimes appears following menstruation, pregnancy, or childbirth; and, in like manner, epilepsy and hysteria manifest themselves at the first appearance of the signs of puberty. Education and habits exercise a similar influence. Harsh usage and excessive severity, as also complete lack of discipline and watchfulness, have often deplorable effects on the brain of children. Alcoholic excesses and high living are extremely injurious to those whose parents had the gout or the gravel, just as squalor and bad air decimate those who have in themselves the germs of consumption.

This much at least is certain, that the fatal character of hereditary disease is a great and mournful fact, of which they alone are fully and sadly conscious who have daily to witness its consequences. One must see the premature infirmity, the long-continued suffering, the irreparable catastrophes, the slow, cruel agonies, to which parents oftentimes condemn their children, to form a judgment of the power possessed by the demon of disease which lurks in the depths of their being. We must read the authors who have treated these questions, and especially the great alienists of France, if we would learn what a mysterious and baleful energy is oftentimes brought into the world by the babe as it opens its eyes to the light of day—the poor, innocent, puny creature, which, for this brief moment of illusion, is the object of unbounded joys and blessings, and bright hopes!

In short, we may say that the hereditary transmission, whether of individual peculiarities of anatomical structure and of temperament, or of liability to such and such a morbid condition—and the same holds good for certain bodily aptitudes—is a very frequent, though not constant, phenomenon in animals and in man.

Hereditary transmission of individual peculiarities of the mental or affectional kind, and of aptitudes for such and such speculative or moral activities, is also a phenomenon which may be observed, though more rarely than that just mentioned. When we go through the series of instances and authorities got together and cited by certain writers, we are struck, it is true, by the apparent force of their arguments, and one is ready to assign to heredity a large share in the development of intellect and character, in the genesis of the thinking individual. We do not see, we forget, the immense number of facts which stand on the other side. The illusions of these mirages have not been useless, seeing that they have led to researches of great interest; but they would be dangerous if they were to be taken by the public as demonstrating the conclusions drawn by some writers. We will state, in brief, the substantial benefits accruing from the researches, and we will then try to refute the conclusions.

According to Galton, the memory was so notable a faculty in the family of the celebrated English Hellenist, Porson, as to have passed into a by-word, *the Porson memory.* Lady Hester Stanhope, she whose life was so full of adventure, gives, as one among many points of resemblance between herself and her grandfather, her retentive memory. "I have my grandfather's gray eyes," said she, "and his memory of places. If he saw a stone on the road, he remembered it: it is the same with myself. His eye, which was ordinarily dull and lustreless, was lighted up, like my own, with a wild gleam whenever he was seized with passion." The imaginative and creative faculties, those which play the chief part in art and in poetry, are sometimes transmitted from father to son. Galton, in the work he published four years ago ("Hereditary Genius"), and Ribot, in his recent book, give long lists of painters, poets, and musicians, in order to show the part played by heredity in the genesis of these artists' talents. There are in these lists many instances in which this influence of heredity is indubitable, but there are far more in which it is very questionable indeed. Thus, these authors see the influence of heredity in the poetic genius of Byron, Goethe, and Schiller, because they find in the ancestors of these poets certain passions, vices, or qualities—just as though these peculiarities of character could determine poetic genius. The fact is, these lists do not show us any great poet who received his faculties from his ancestors. We do there find that a great poet is sometimes the father of mediocre poets—which is a different thing. The heredity of aptitudes for painting is better established: in a list of 42 celebrated painters, Italians, Spaniards, and Flemings, Galton shows that 21 had illustrious ancestors. The names of Bellini, Caracci, Teniers, Van Ostade, Mieris, Vandervelde, and Vernet, will suffice to prove that there are families of painters. In the family of Titian we find nine painters of merit. The history of music presents instances still more striking. The Bach family took its rise in 1550, and became extinct in 1800. Its head was Veit Bach, a baker at Presburg, who used to seek for relaxation from labor in music and song. He had two sons, who commenced that unbroken series of musicians of the same name, who, for nearly two centuries, overran Thuringia, Saxony, and Franconia. They were all organists, church singers, or what is called in Germany city musicians. When they became too numerous to live all together, and the members of this family were scattered abroad, they resolved to meet once a year, on a stated day, with a view to keep up a sort of patriarchal bond of union. This custom was kept up until nearly the middle of the eighteenth century, and oftentimes more than 100 persons bearing the name of Bach, men, women, and children, were to be seen assembled. In this family are reckoned 29 *eminent* musicians, and 28 of a lower grade. Mozart's father was second capellmeister to the prince-bishop of Salzburg. Beethoven's father was tenor in the chapel of the Elector of Cologne: his grandfather had

been chanter, and then master in the same chapel. Rossini's parents played music at fairs.

We find almost as effectual and continuous an intervention of heredity in the transmission of passions and sentiments of a very different order—those which incline to vice. The liking for strong drink, habits of debauch, a passion for gambling, acquire in some persons a degree of force which can be accounted for only by some fatal organic predisposition derived from their ancestors. "A lady with whom I was acquainted," says Gama Machado, "and who possessed a large fortune, was possessed of a passion for gambling, and passed whole nights at play: she died young, of a pulmonary complaint. Her eldest son, who was in appearance the image of his mother, had the same passion for play. He died of consumption, like his mother, and about the same age. His daughter, who resembled him, inherited the same tastes, and died young." The heredity of a disposition for theft, rape, murder, and suicide, has been proved in several instances.

In proportion as you rise above the purely physiological and pathological regions to those where the mind's activity takes a larger part, heredity is found to lose force and constancy of action. There have been families of scientists—the Cassinis, Jussieus, Bernouillis, Darwins, Saussures, Geoffroys, Pictets. In literature and erudition, the names of Estienne and Grotius, and others, occur. The Mortemarts were famous for their wit. A genius for statesmanship or for generalship has sometimes been perpetuated for several generations in certain families. On the whole, these cases of the transmission of psychical qualities are not frequent. Their being so carefully noted and so set in relief is apparently due to the fact that they are not of common occurrence; and besides, in many of these cases, education had probably more to do than heredity.

Some years ago there appeared a book entitled "Phrenyogenie," in which is to be found, side by side with many chimerical and paradoxical statements, one reflection worthy of attention, and this all the more because it takes account of a peculiarity which appears to have escaped the physiologists hitherto. The author of that book, M. Bernard Moulin, strives to prove that children are living *photographs* of their parents, as they were at the moment of conception. According to him, the parents transmit to the children the tastes and aptitudes, the spontaneous or the elicited exercise of which was then at the maximum. The broad conclusions which Moulin draws from his researches, as to the art of procreating superior children, may perhaps call forth a smile, but the facts cited by him in support of his views are curious. Here are a few of them: Nine months before the birth of Napoleon I., Corsica was all in confusion. The celebrated Paoli, at the head of an army of citizens which he himself had raised, was endeavoring to put an end to the civil war, and to prevent an invasion by foreigners. Charles Bonaparte, his aid-de-camp and secretary, displayed great

courage at the side of his commander. The young officer had with him his wife, Letitia Ramolino, a woman of Roman beauty, and of a strong and masculine character. Napoleon was conceived in his tent, on the eve of a battle, at the distance of two paces from the batteries which faced the enemy. Robespierre was born in 1758, the year which saw Damiens tortured and dragged about the Place de Grève, a year of war, of famine, and of discontent. His father was an attorney, and an insatiable reader of the "*Contrat Social.*" Peter the Cruel, King of Castile, was the son of Alfonso XI., who was ever at variance with his wife. Scandalous scenes of anger, jealousy, and rage, continually disturbed the royal household, and the fruit of the commerce of this wedded pair was Peter the Cruel, a monster of ugliness, physical and moral. History shows to us the parents of Raffaelle both devoted to the art of painting. The wife, a true Madonna, delighted in subjects where grace and piety prevailed; the husband, a great dauber, preferred strength for his part.

M. Ribot, in the remarkable work which he has just written on the subject of heredity, investigates the laws of this mysterious influence, which he regards as a sort of habit, an eternal memory. These laws are little more than a statement of the habitual directions of hereditary impulsion. Sometimes heredity passes from the father to the daughter, from the mother to the son; again the child inherits from both parents. Finally, it often happens that the child, instead of resembling his immediate parents, resembles one of his grandparents, or some remote member of a collateral branch of the family. This is called *atavism.* This fact was well known to the ancients. Montaigne regarded it with wonder. "Is it not astonishing," says he, "that this drop of seed from which we are produced should bear the impression not only of the bodily form, but also of the thoughts and the inclinations of our fathers? Where does this drop of water keep this infinite number of forms? and how does it bear these likenesses through a progress so hap-hazard and so irregular that the great-grandson shall resemble the great-grandfather, the nephew the uncle?" Montaigne's wonder has good ground; nor do we to-day know any better than those of the sixteenth century the causes of these strange transmissions.

Such are the facts. In vain would we multiply them, or comment upon them, to change their character. Cases of heredity will never be, in the domain of physiology, any thing more than exceptions, as compared with the cases which make against heredity. But now, if these are only exceptions, by what right shall any man set up heredity as the general law of the development of intellectual activity, or affirm that heredity is here the law, non-heredity the exception? Ribot accumulates the subtlest of arguments to strengthen this singular proposition, but he is wasting his time, wasting his talent. Explain as you will how the heredity of intellectual aptitudes is almost ever overcome

by antagonistic or disturbing causes, the fact remains that heredity has not the upper hand. With what ingenious reasons soever you console yourself on seeing the ideal sovereignty of heredity brought down, in matter of fact, to a very low grade of authority, still heredity is not helped. In a word, if non-heredity has in fact a far wider empire than heredity, the question arises, Why does M. Ribot adopt a formula which implies the contrary?

Besides, does not the history of the development of civilization itself show existing in man the preponderant force of an eternal tendency to metamorphosis, to innovation, and to change? Fixedness of thoughts and immobility of habits were, it is true, the law of primitive peoples, as they still are of savage tribes; but then there is nothing to show that this is owing to heredity. This more or less protracted repetition of identical societies should rather, we think, be attributed to the strong and irresistible instinct of imitation and to the profound respect entertained for rites and customs established by religion. Among such peoples the future is like the present, and the present like the past, because the same inflexible rule, the same authority, and the same tyrannical superstition are imposed on them all. Nothing possesses strength or obtains respect except through tradition, and tradition among such people is only the revered memory of the will of the mysterious powers, manifested in days of yore. When the English would have the Hindoos take a part in road-building and the hygienic improvement of their country, they have still to show that the usefulness of such enterprises was understood by the most ancient Brahmans—so hard is it for this old race to conceive of a law which should be obligatory without being traditional.

However that may be, and whatever part heredity may act here, certain it is that this part is not important, since this singular homogeneity of primitive races, instead of being maintained and growing stronger, does, sooner or later, give place to diversity. Every people is in turn invaded by a force at once capable of acting counter to its hereditary influences, and of releasing it from the iron yoke of antique customs. It was in Greece that about 3,000 years ago the first movement of this force brought about what Goethe calls "the liberation of humanity." Since that day the crossings of distinct races, the many new wants, and the various inventions to which they have given rise, and the ideas which men, owing to their more and more intimate contact with Nature, have conceived, have set in the place of primitive simplicity a multiple and irresistible variability, as the present state of the world clearly shows.

THE SHOVEL-NOSED SHARK.

By Lady VERNEY.

THE following sketch from Nature (Fig. 1) represents the jaw of a young shark—a tender innocent, indeed, for, if his life had not been cut short by cruel Fate, he would have attained to the dignity of nine rows of teeth, instead of the poor five which, as you may see inside the mouth, this little victim had been obliged to put up with. A shark's age is counted by the number of rows—and his jaws are the most awful engine of destruction which exists in the animal world: the best possible means that could be devised to seize, to cut and tear, and finally to hold fast any slippery subject, though of no use to chew or masticate.

Still there seems a superfluity of naughtiness in this array of edges and serrated points, set thus, one range following up another, as shown in Fig. 2. What *could* he want with five rows of teeth? It is almost dangerous to run one's finger over them; the points are like knives, the jagged edges along the finely-modulated curves of each three-cornered tooth are so keenly sharp.

There is a sort of hinge in the middle of both upper and lower jaw, and from this centre the teeth point different ways, gradually diminishing to a mere root. Each is a brightly polished piece of ivory, and each little jag of the graduated saws is exquisitely finished, and varies according to its position. The mouth in question only measures nine and eleven inches across, and is about two feet round, but in a full-grown monster the jaws are wide enough to pass over a man's shoulders without touching them. The snout is rounded, with very small eyes almost at the top of his head.

The shark is the scavenger of the sea, the equivalent of the hyena on land, and he swallows whole whatever offal is flung overboard from the ships—bolting it without any action of the teeth, unless when his prey is too large to go conveniently down his throat, and he breaks it up as it passes.

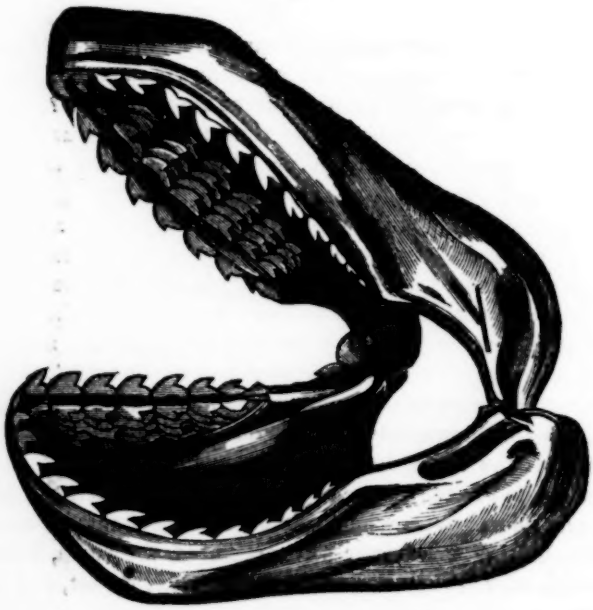
The stomach-coats are extremely strong, and some action seems to go on in it to prepare the food for the gastric juice, as a substitute for the mastication with which other warm-blooded animals reduce it to a pulp in their mouth.

He is so fearless in his voracity, and follows a ship so pertinaciously, that his habits are better known than most of the sea-denizens, and familiarity does not certainly in this instance breed either respect or affection.

With the passengers on board the merchant-vessels to and from Australia, shark-fishing is a favorite pastime. One of these, lately

caught, was twenty feet long. "Our ship was at anchor, and I was holding a line over the side, when the rope began to quiver. I felt that I had hooked a large fish, and, pulling it cautiously, a large shark came to the surface. I called out loudly, when all the passengers came to my help. He struggled, however, so violently, lashing the water with his tail, and trying to bite the hook asunder, that we were obliged to keep dipping his head under water, and then haul him up two or three feet so that the water ran down into his stomach. We went on repeating this till he was nearly drowned, then sending a running bowline down the rope by which he was caught, and making it taut under his hindermost fin, we clapped the line round the steam-winch, and turned the steam on. Some then hauled his tail up, while all available hands dragged at the other line which held his

FIG. 1.



THE JAW OF THE INFANT SHARK.

head. As soon as we got him on board, he sent about three feet of the ship's bulwarks out by a lash of his tremendous tail—which was cut off by the boatswain with a hatchet, while a dozen of us with bowie-knives finished him and opened his maw. Inside we found six large snakes, two dozen lobsters, two empty quart-bottles, a sheepskin and horns, and the shank-bones of beef which the cook had thrown overboard two days before. The liver filled two large wash-deck tubs, and when the cook melted it down we got ten gallons of oil, which sold at Brisbane at 4*s.* 6*d.* a gallon." When his remains were thrown

over the side, they were as usual very soon disposed of by his affectionate friends and relations, waiting near, and delighted to profit by the good fortune. The flesh is not bad eating when young.

The shark is always attended by a small blue pilot-fish, which swims about five yards in front of him, and evidently guides him and warns him of danger, his unwieldy size and length making it difficult for him to turn. The pilot-fish appears to do his kindly offices from pure friendship, with no filthy lucre of gain; but he probably benefits in some way by the leavings of his great ally, or the small fry which gather round a dead prey. There is another (strictly speaking) parasite which attends the shark—the sucker-fish, about sixteen inches long, which fastens itself on to him by a curious patch at the back of its head, not unlike the sole of an India-rubber shoe: this adheres with such force that a strong man can hardly drag the fish away when it has thus fastened itself to the deck. Sometimes twelve or fifteen of them may be seen hanging on to one shark. Probably they find it convenient to seek their food, thus traveling, as it were, on their own carriage, free of cost or trouble, and rushing through the water at a rate which their unassisted exertions would certainly never attain.

FIG. 2.

SHARKS' TEETH.

But, on the other hand, they must endure some very hard quarters of an hour, when their great friend gets into trouble, helplessly hanging on to his fortunes as they are.

The perils of the sea are certainly doubled in the regions where these dreadful jaws are to be found. And the certainty of such a death was one of the most touching parts of the simple heroism shown by the soldiers on board the Birkenhead. As is well known, she was a transport-vessel employed to take out detachments to various regiments in South Africa, with the wives and children. She struck on a pointed rock near Simon's Bay, and it was soon found impossible to save her. The men were drawn up on deck by their commanding officer, and not a man stirred from his place as the women and children were put into the few boats and sent off in safety to the land. Then, standing as firmly as if on parade, with the sharks swimming around, the whole body of men, with their officers, went down in the ill-fated ship, very few of them being able to reach the shore.

There are more gallant things done in quiet, unobserved moments, and obscure corners of the earth, even than before the enemy. It

was far more difficult thus in cold blood to face a dreadful death, with no excitement or sympathy from without, than to fight a whole array of cannon in a Balaklava charge.

A young engineer-officer, some years back, was stationed in New Zealand, in a very out-of-the-way district, far from the settled country. He was a gallant fellow, full of high aims and objects; besides which he rode well, shot well, could manage a boat, and swim admirably, and had attained a twofold influence over the natives by his fearless courage and his noble nature.

One stormy winter's afternoon, the sea running excessively high, and a tremendous surf over the bar, a ship was seen laboring into the roadstead of the small village near which he lived; she was hoisting signals of distress, and was believed to be an expected immigrant-vessel, and therefore with women and children on board.

The weather was so bad that there seemed no chance of her outliving the gale, and not a sailor on the shore would lend a hand to help, when Captain Symonds proposed to man a boat. Perhaps it may be said that they knew the perils to be encountered better than a landsman, however expert. Captain Symonds then called upon the Maories to join him, and they immediately followed him into a risk of life which the Englishmen refused to encounter, and for the sake of sufferers not of their own race or country.

The boat pushed off; the wind was on the shore, the surf running in violently, and a cross-sea made it more dangerous; the bay, too, was known to be full of sharks. Still, however, the little boat held on till within a few cables' lengths of the distressed vessel, which was watching them anxiously, when the tremendous heave of a wave struck her side and she was capsized. Captain Symonds was seen swimming undauntedly toward the shore, holding on by an oar, but he was swallowed up by the sharks before he had made any way. Two of the gallant black fellows escaped. The vessel perished in the gale.

It required a far higher kind of courage to face such a death, on that dark stormy winter's evening, in the attempt to rescue unknown passengers on board an unknown ship, than to storm the worst breach ever surmounted in war, surrounded by one's comrades in the heat of a battle raging in one's sight. The simple doing of God's work at the moment when it was required, with no interior bargaining as to the "worth while" of the sacrifice, in this obscure corner of the earth (as it then was), by this young fellow, with his aspirations, his love of life, his healthy longing after distinction, and the distinguished career open to him, made his death as gallant an act as can be found even in the long record of such deeds to be told of our English soldiers and sailors, the largest portion of which are scarcely heard of at the time, and are forgotten quickly afterward.

The sharks are certainly not heroic themselves, but they are the cause of a great deal of heroism in others.—*Good Things.*

HEALTH AND COMFORT IN HOUSE-BUILDING.[1]

By Dr. JOHN W. HAYWARD.

AS implied in the title, my subject is not house-building itself, as such, but only certain arrangements for health and comfort therein. House-building has at least two aspects—architectural and sanitary. The former belongs exclusively to your own profession, but the latter comes within the sphere of the medical profession also. It is the architect's province to provide dwellings for the people, and to see that they are made protective and safe; and it is part of the medical man's province to help to make them healthy and comfortable. In this respect the medical profession has lately been very forcibly reminded of its duty by Mr. George Atchison, who said: "No greater benefit could be conferred on mankind than the teaching them the necessity of ventilation, but that lesson is more likely to be learned if it come from the doctor than from the architect. . . . Until the faculty can convince the people that their life is shortened and serious diseases are brought on by want of ventilation, architects have no chance."

House-building being the point in which the duties of the architect and the physician meet, it becomes necessary that architects and medical men should occasionally discuss together the requirements involved in this art. Much public and much mutual benefit would, I am sure, result from such a practice. The object I have now in view is to invite your consideration of a few conditions of house-building that I deem of particular importance in a sanitary and medical point of view.

In building a dwelling-house, the conditions I deem of essential importance are the following:

1. That the house shall be so placed as to be as much as possible exposed to the fresh air and sunlight; *because* fresh air and sunlight are essential to the health, and growth, and life of the occupants. The *site*, therefore, should be rather elevated, if not absolutely, at all events in comparison with the surrounding objects.

2. That it shall be absolutely free from damp; *because* a damp house is a most potent, and active, and ever-present cause of disease, especially of rheumatism, neuralgia, colds, coughs, consumption, and such like. The site, therefore, if not naturally dry, must be rendered so by means of asphalt or cement, throughout the foundation, and the roof, and gutters, and drainage must be perfect. All the house-drains should terminate outside the house on an open grid or trap; that is, they should be cut off from the street drain, and they should be ventilated by having a pipe run up from every soil-pipe and every bend in the house.

[1] From a paper read at the Royal Institute of British Architects, Liverpool.

3. That it shall be so placed that the direct rays of the sun shall have free admission into the living apartments; *because* the sun's rays impart a healthy and invigorating quality to the air, and stimulate the vitality of human beings as they do those of plants, and without sunlight human beings, as well as plants, would sicken and die. The *aspect*, therefore, should be southeast.

4. That the lookout from the living apartments shall be cheerful, lively, and interesting; *because* much of the time of the family must be spent indoors, and a cheerful lookout is as necessary to render indoors attractive and even endurable in the daytime as society is in the evening. The *prospect*, therefore, should be as extensive and varied as possible.

5. The apartments should admit into themselves a great quantity of light; *because* light is essential to the health and vigor of the inmates. The *window openings* should, therefore, be large; but, as the greater the surface of glass, the colder the rooms in winter, and the hotter in summer,

6. The window-openings should be well splayed, as well outside as inside, so as to do with as little glass as possible.

7. The *windows* should be so arranged as to admit the direct rays of the sun at the times when the apartments are in use; *because* it is when the apartments are occupied that they require the cheering and invigorating influence of the sun's rays. For instance, the breakfast-room window should admit the early morning rays; the dining-room windows, one should admit the morning rays for breakfast-time, and the other the noon rays for dinner-time; and the drawing-room windows, one should admit the morning rays for callers, and another the evening rays for company; and the bedroom windows should, if possible, admit the early morning rays.

8. The *interior* of the apartments should provide wall-space for the arrangement of furniture; *because*, without wall-space no manner of furnishing a room can make it either handsome, elegant, or comfortable. The *windows*, therefore, should be few, and they and the door and fireplace should be so arranged as to provide as much wall-space as possible.

9. In the bedrooms, the window, door, and fireplace, should be so arranged that the bed can be fixed entirely out of the draught, and not have to be placed between the window and door, the window and fireplace, or the door and fireplace; *because* a cold draught playing on persons while sleeping is often dangerous to life, and always destructive of comfort.

10. The *doors* of the apartments, besides not admitting cold air when shut, ought not to admit cold air when open; *because* the draught thus produced not only destroys the comfort of the apartment, but produces lumbago, rheumatism, neuralgia, etc., in the occupants. The *doors* should, therefore, open out of a warmed lobby or corridor.

11. The *apartments* should provide a large cubic space for air; *because* plenty of air is essential to the health and comfort of the inmates. The apartments should therefore be as large and lofty as possible.

12. The apartments, besides providing a large cubic space for air, should also provide for the escape of the foul and admission of fresh air; *because*, however large an apartment is, the air is sure to become deteriorated and contaminated when the apartment is occupied by living beings. There should, therefore, be *two special openings* to each apartment, one for the escape of the foul air, and another for the admission of fresh air. There must be *two openings*, an outlet and an inlet. It is useless to make one without the other; it is useless to make an outlet unless there is also an inlet, for no air can go out if none comes in. This is a self-evident fact; still it is very frequently disregarded in attemping to ventilate apartments. There will, for instance, be a perforated or louvered pane in the window, a perforated brick or grating in the wall, an Arnott's ventilator in the chimney-breast, an opening above the gas, with a tube leading to a grating in the wall or into the chimney smoke-flue, or some other contrivance for the escape of the foul air, while there is no opening at all for the admission of fresh air; and the doors and windows are made to fit as tightly as possible, and even list put round them to prevent any possibility of air getting in by them, as though that could go out which never got in! In these cases, if the outlet act at all as an outlet, it must obtain its supply down the chimney—hence a smoking chimney; but generally, instead of acting as an outlet, it becomes an inlet to supply the current up the chimney, and always so when the fire is burning—hence the cold draught so generally complained of from the ordinary ventilators, and hence the reason that ordinary ventilators are so generally closed up in disappointment and disgust, and ventilation decried as a nuisance, failure, and farce.

13. These *openings* providing for the escape of foul air and the admission of fresh air should, both of them, be *special and permanent*, and altogether independent of every other arrangement of the house; such as opening the windows, doors, chimneys, etc.; *because* the escape of foul air and the admission of fresh air are most needed when, in consequence of the coldness of the external air, we close the doors and shut the windows. Special *ventilation* is most needed in winter, in cold, frosty weather, with an east wind blowing, and when we are very careful to shut the doors and windows, and adopt every other means we can to exclude the out-of-doors air, particularly of sitting at table for meals, or round the fire for evening entertainment.

14. The *outlet* should take the foul air from the upper part of the room; *because* the foul air, being more heated, is specifically lighter than the fresh air, and so rises to the upper part of the room. The outlet should, therefore, be in or near the ceiling.

15. The outlet should be effectually protected against any possibility of back-draught—indeed, it should have a considerable amount of suction; *because* any liability to back-draught is quite incompatible with an efficient outlet. The *outlet*, therefore, should not communicate directly with the out-of-doors air, but, by means of a tube or flue, should pass through some permanently heated contrivance. If the outlet go directly to the out-of-doors air—as, for instance, a tube from over the gas to a grating in the outer wall—there will certainly be back-draught; and so also will there be if the tube lead to an opening into the chimney-flue; at any rate, when the fire is not burning, and particularly if the room-door be also open, and most certainly if there be also a strong draught up the chimney of another room opening out of the same lobby, as, for instance, a dining-room or a kitchen. To prevent any possibility of back-draught the outlet should be provided with some means of constant suction, and, the more thoroughly to remove the foul air, the more suction the better, provided there is also an ample inlet for fresh air: if not ample, the suction would produce a smoking chimney and draughts from around the windows and doors, and perhaps draw in air from foundation and drains. The necessity for this suction is generally acknowledged, and it is sometimes attempted to be gained by carrying the tube before mentioned up a little way in the smoke-flue, and even by bending it down and round the fireplace. But a fatal objection to this plan is, that it is quite inoperative for the greater part of the year, and is of no use whatever unless the fire is burning; when the fire is not burning it may, indeed, become an inlet, and then an additional objection is, that a back-draught down the smoke-flue carries the soot into the room, to the spoiling of the ceiling, paper, and furniture. And, to be really effectual, the suction referred to must be *constant* and *permanent*, and operative both winter and summer, and day and night; and whether the apartment is occupied or not, and whether the fire is burning or not. The *outlet* must, therefore, pass through some contrivance for keeping it constantly and permanently heated.

16. The *inlet* should admit only warmed air; *because* the admission of cold air would produce dangerous draughts, and these specially directed toward the part of the room occupied by the inmates in cold weather, viz., the neighborhood of the fireplace. The *inlet* should, therefore, open out of a warm lobby or corridor.

17. The *outlet* should be sufficiently large to carry off all the foul air at the time when the apartment is being put to its maximum of use; *because* it is just at that time the outlet is most needed, its capacity for other times could be regulated by a valve. The outlet for a dining-room, for instance, should be calculated for a dinner or supper party, and that of a drawing-room for a ball, *conversazione*, or *soirée*, and should be sufficiently capacious to carry off, at the very least, fifteen cubic feet per minute for each occupant. The outlet should,

however, be considerably less than the inlet, or it will produce draughts.

18. The *inlet*, on the contrary, should be as capacious as possible; *because* it has to provide not only for the outlet in the ceiling, but also for the chimney, and that when the fire is burning and requiring for its supply alone from 600 to 1,000 cubic feet per minute. Indeed, the *inlet* should be able to admit more air than can possibly find its way out by both these outlets, otherwise it will produce draughts. When the air can get out of an apartment more rapidly than it can come in, there are sure to be currents; but when more air can come in than can get out—when the air has to go out under pressure, so to speak—there will be little or no current. And the *inlet* should be through the wall of the opposite side of the room to the fireplace; *because* the fire will then draw the air into and across the room, and thus cause it to circulate throughout the whole of the apartment. If the fireplace be on the same side as the inlet, it will not only not assist to circulate the air throughout the apartment, but it will prevent it from so circulating by drawing it directly up the smoke-flue; and it should, moreover, be split up into as many divisions as possible, so as to distribute the supply along the whole side of the room, and thus assist to prevent any perceptible current; and this will be further helped by having the openings through the cornice instead of through the skirting, because then the fresh air will be the warmest that is in the corridor, and it will also have to descend through the warmer air of the room before it can come in contact with the persons therein. When through the skirting, it is the coldest air of the corridor; it comes through the coldest air of the room, and it comes first to the part of the body where it can least be borne, viz., the feet.

In this country (England) it is necessary to provide specially for ventilation. In consequence of the nature of our climate, the doors or windows can very seldom be left open, even in the day, and never in the night, without risk. Indeed, no direct admission of the external air into the apartments of the house can be endured during at least eight or nine months of the year—in fact, the great prevalence of cold, searching, and shriveling east wind renders such an admission absolutely dangerous; so that no kind of arrangement of openings directly to the out-of-doors air, such as drawing down the window-sash, perforated bricks or gratings in the wall, perforated or louvered square in the window, the wire-gauze at the top of the window-sash, patent ventilators, or any other contrivance that communicates directly with the out-of-doors air, can possibly answer for ventilation in a country like ours. In this country, where eight or nine out of the twelve months in the year are cold, windy, and winterly, houses should be built with reference to winter, and not with reference to summer; and they should be planned and built with the object of keeping out the cold air and not with the object of letting it in; ventilation should be pro-

vided for specially; and in making this provision it should be borne in mind that we are living at the bottom of an ocean of air, and that the same manipulation is required as though we were living at the bottom of an ocean of water, and were endeavoring to make it come in at the bottom of the house and go out at the top in a continuous stream.

From the foregoing remarks it will be seen that I maintain that *ventilation* is the great and main necessity of house-building; and that, whatever else may be left undone, this should be attended to; and, whatever else may be left imperfect, this should be made perfect and complete; and that it should include the whole house; and should be self-acting and inexpensive. It should, I repeat, be perfect and complete, include the whole house, and be self-acting and inexpensive.

Ventilation is *the* point for discussion between the architectural and medical professions, for it is here in particular that their duties meet and combine; the education, knowledge, and experience of both professions are wanted here. However much the medical man may be impressed with the absolute necessity of rooms and houses being ventilated, he cannot himself provide it—this must be done by the architect; and, on the other hand, the architect cannot be expected to provide flues and tubes, which involve extra expense, except under the certainty that they are absolutely necessary and required arrangements involved in the plan of every house. But there is a third party interested in this subject, namely, the public. The public are, after all, the "yea" and "nay" in this matter; it is, indeed, for them that these arrangements are to be made, and they are the paymasters. Whatever extra cost is involved, it is the public that will have to pay it; and it is of little use for a doctor to prove the necessity, or for an architect to design the arrangements, unless the public be persuaded to adopt them, and pay the cost involved. That the public can be thus persuaded I have no doubt, but that this will take some time I am equally ready to admit. It will take some time thoroughly to educate the public into the absolute necessity for special provisions for ventilation, because they have hitherto been left under the impression that special arrangements for ventilation are unnecessary and superfluous, or that they are impracticable, or at least incompatible with warmth and comfort; and I am sorry to have to add that they have been encouraged in this impression by many architects and engineers, and that medical men have not protested with sufficient force and intelligence. Medical men have gone on from generation to generation silently mourning the resulting evils of the want of efficient and practicable means of ventilation, and architects have continued to design houses with very little regard to these absolutely necessary provisions; while the public have submitted, and, if they have not thought it was all right, have at least thought that the evil was quite beyond

their remedying, because every amateur (if not every professional) attempt hitherto made had only ended in failure, disappointment, and loss of money.—*The Builder.*

HYPNOTISM IN ANIMALS.

By Prof. JOSEPH CZERMAK.

TRANSLATED FROM THE GERMAN, BY CLARA N. HAMMOND.

Lecture Second.

YESTERDAY we proceeded far enough in our study of Kircher's experiment, relative to the imagination of the hen, to establish the fact of the usefulness of the string and chalk-line as necessary parts of the procedure. Indeed, the stretching out of the neck and the depression of the head are the only circumstances left which make any decided impression on us. And, so far as we can see, the gentle extension of certain parts of the brain and spinal cord which is produced, appears to be the cause of the remarkable effect which ensues. Nevertheless, we must not be too hasty in forming our conclusions; we must not, as the unlearned do, remain standing at an "event viewed unequally."[1] For, however apparently useless the string and chalk-line may be, it is yet possible that they are not entirely without influence; and, on the other hand, the extension of the neck and depression of the head are by no means established as necessary circumstances to the perfection of the result. So, to-day, as already announced, we will resume and complete our investigations, and, at the close, I will endeavor to show what relation the whole subject has to natural science, to "spiritualism," etc.

And I must request you to dismiss from your minds the hypothesis that the extension of the neck and depression of the head have any especial significance, for I have been entirely unable to produce in pigeons the hypnotic effect which so readily ensues in hens, although I proceeded in as nearly as possible a similar manner. On the contrary, repeated experiments have shown that the unavoidable pressure exerted upon the animal, as it is held, is of primary importance, and that the apparently insignificant chalk-line is undoubtedly of some moment. It is frequently the case that a hen, which, for a minute, has been in a motionless state, caused by simply extending the neck and depressing the head, awakes and flies away, but, on being caught again immediately, can be placed once more in that condition of lethargy, if we place the animal in a squatting position, and overcome with

[1] By this phrase Prof. Czermak (pronounced Tshermak) means those cases of observation in which the eyes and ears perform correctly, but the perception is at fault. The reporter tells the truth, but what he reports never actually took place. An *event viewed unequally* is one that has not been thoroughly tested.

gentle force the resistance of the muscles, by firmly placing the hand upon its back. During the slow and measured suppression one often perceives an extremely remarkable position of the head and neck, which are left entirely free. The head remains as if held by an invisible hand in its proper place, while the neck is stretched out of proportion, and the body by degrees is pushed downward.

If the animal is left thus entirely free, it remains for a minute or so in this peculiar condition, with wide-open, staring eyes. (The lecturer here caused a hen to be brought, which he placed in this remarkable position by simply stretching out the neck and pressing down the head; the bird, having awakened, gave signs of returning to the same state when it was placed in a squatting position, without moving head or neck.) Here the actual circumstance is only the consequence of the emotion which the nerves of the skin excite, and the gentle force which overcomes the animal's resistance. Certainly, the creature a short time before had been in this condition of immobility, and might have retained some special inclination to fall back into the same, although the awakening, flight, and recapture, together with the refreshment given to the nervous system, are intermediate circumstances. Similar experiments, where the influence and effect of the pressure which is placed on the animal's muscles are manifested upon the cutaneous nerves, are best made upon small birds.

To bird-fanciers, it has been a long-known fact that one can rob gold-finches, canary-birds, etc., of the powers of their nervous systems, so that they remain motionless for a short time, by simply holding them firmly for a moment, and then letting them go.

These experiments, which I will endeavor to perform before you, are particularly striking, on account of the vivacity of the timid animals. Yet I must remind you of a possible failure, due to the unusual circumstances of noise and numbers which may have a disturbing influence on these excitable little creatures.

Here in my hand is a timid bird, just brought from market. If I place it on its back, and hold its head with my left hand, keeping it still for a few seconds, it will lie perfectly motionless after I have removed my hands, as if charmed, breathing heavily, and without making any attempt to change its position or to fly away. (Two of the birds were treated in this manner, without effect, but the third, a siskin, fell into a sleeping condition, and remained completely immovable on its back, until pushed with a glass tube, when it awoke and flew actively around the room.)

Also, in a sitting position, with the head held a little to the back, the birds fall into this sleeping condition, in spite of their open eyes; indeed, I have often noticed that the birds under these circumstances close their eyes for a few minutes, and even a quarter of an hour, and are more or less fast asleep.

I cannot omit to notice, with many thanks, that our assiduous nat-

uralist, Herr Geupel-White, has most kindly placed at our disposal the rich material his zoological garden affords, to assist us in these experiments.

My former experiment with the swan was also performed in Herr Geupel-White's garden. In the experiments with the small birds, the condition of immobility, which can change to actual sleep, is only caused by the effect of the impression made in the animals, through touching the skin and overpowering the resisting muscles. You will see this in the continuation of our experiment. That, however, the exciting of certain cutaneous nerves alone changes the normal functional capacities, and calls forth a singular state of stupidity, is proved by the following highly-interesting experiment with a frog, which Dr. Lewissohn, in Berlin, has suggested, and most thoroughly investigated:

If one places a frog on its back, it does not remain in this unnatural position for an instant, but, on the contrary, turns itself over and escapes. This you may see yourselves, when I endeavor to place this frog on its back. But please notice the astonishing result if we tie its two fore-legs with a string. (The lecturer tied threads around each of the frog's fore-legs, drew the threads tightly, and laid the animal, as before, on its back.) You see that the frog, breathing heavily but otherwise quite motionless, now lies on its back, and does not make the slightest attempt to escape, even when I endeavor to move it. It is as though its small amount of reasoning power had been charmed away, or else that it slept with open eyes; an analogous condition to that which we saw in the crabs, hens, and little birds. The only difference is, that the actual connection of the phenomena is much clearer. Now, I press upon the cutaneous nerves of the frog, while I loosen and remove the threads on the fore-legs. Still the animal remains motionless upon its back, in consequence of some remaining after-effect; at last, however, it returns to itself, turns over, and quickly escapes.

That it is here a matter of restraint upon the nervous centres, in consequence of the pressure on the sensitive cutaneous nerves, Lewissohn has already proved. In this experiment, the impulse of motion on the nervous fibres, which proceeds from the so-called motory centre of the brain and spinal cord, remains quite capable of action on one side, while, as regards the other side, the remarkable condition of stupidity will no longer happen, if we have divided the cutaneous nerves before tightening the threads.

Sometimes it is possible to make the frog lie motionless on its back without the threads; but this proves nothing against the soundness of Dr. Lewissohn's results.

But let us return to our old *experimentum mirabile*[1] of the hen. According to the analogy of the last experiments with the frog, the tying together of the hen's feet, although not necessary, may contribute something to the effect in Kircher's experiment, not only by

[1] Admirable experiment.

keeping the animal firm and quiet, but also by pressing upon the cutaneous nerves. In order to understand the whole subject, we must go further and adduce other facts which bear upon it.

The most interesting part of our investigation still remains, which, as I remarked beforehand, will lead us to the doubtful regions of mesmerism and somnambulism. And the question arises again: Has the apparently unnecessary chalk-line in Kircher's experiment any significance; and, if so, what?

I have already mentioned that I did not succeed in placing pigeons in this motionless state by holding them firmly in my hand, and pressing their heads and necks gently upon the table, as I did the hens.

I therefore endeavored to treat the pigeons as I did the little birds, that is, I held them with a thumb placed on each side of the head, which I bent over a little, while the other hand held the body gently pressed down upon the table.

Even this treatment, which has such an effect on little birds, did not seem to succeed at first with the pigeons. Almost always they flew away as soon as I liberated them and entirely removed my hands. I remarked, however, that the short time, during which the pigeons remained quietly in my fingers, increased visibly, and lengthened several minutes, when I removed the finger of the hand which held the head, only removing the hand very little, or else not at all. The hand holding the body could have been removed much sooner without doing any harm.

While I zealously pursued this trace of new events, I found, to my astonishment, that it led me to the observation of the pigeon's attention, and the fixing of its look upon my finger placed before its eyes. It is this movement which, until now, has not been taken into our consideration, and is the critical period which is of such great importance as a link between the phenomena we have noticed and others to which we are gradually approaching. In order to determine the matter still more clearly, I tried the experiment on a pigeon which I had clasped firmly by the body in my left hand, but whose neck and head were perfectly free, and held one finger of my right hand firmly before the top of its beak—and what did I see? The first pigeon with which I made this attempt remained rigid and motionless, as if bound, for several minutes, before the outstretched forefinger of my right hand!

Yes, I could take my left hand, with which I had held the bird, and again touch the pigeon without waking it up; the animal remained in the same position while I held my outstretched finger still pointing toward the beak. (The lecturer demonstrated this experiment in the most successful manner with a pigeon which was brought to him.)

I have repeated this striking experiment on a number of pigeons, yet I do not know whether suitable animals are frequently found, for, of course, it is to be understood that the experiment cannot always

entirely succeed, as it concerns essentially the concentration of the pigeon's attention, and the fixing of its look. Individual, inward relations, as well as outward conditions, must necessarily exercise some disturbing influence, whether the animal will give itself up to the requisite exertions of certain parts of its brain with more or less inclination, or otherwise. You then understand why apparently little circumstances may be responsible for the result of an experiment in which this critical moment plays a part.

We often see, for example, how a pigeon endeavors to escape from confinement by a quick turning of its head from side to side. In following these singular and characteristic movements of the head and neck, with the finger held before the bird, one either gains his point, or else makes the pigeon so perplexed and excited that it at last becomes quiet, so that, if it is held firmly by the body and head, it can be forced gently down upon the table. It is as Schopenhauer says of sleeping, "The brain must bite." I will also mention here, by-the-way, that a tame parrot, which I have in my house, can be placed in this sleeping condition by simply holding the finger steadily before the top of its beak.

But let me hasten, gentlemen, to say to you that, in the remarkable and singular influence which the holding of the finger exercises on pigeons, the influence of the mythical agents may not be removed; agents which may come from the organization of the experimenter, and, perhaps, spring from the outstretched finger. Nevertheless, a glass tube, a cork, a small wax-candle, or any other equally lifeless substance, placed directly on the top of the pigeon's bill, has the same magical effect as when the human finger is used. We must only be careful that the animal be placed so that its attention is fixed for some time on the object. I have seen pigeons sit motionless for some minutes, with open eyes, after I had placed a lucifer-match, or a wax-light, on the top of their bills.

Often, with hens, these experiments succeed in the most astonishing manner. I have repeatedly seized hens with both hands by the body so that their heads and necks were quite free, and forced them gently against a pedestal on which a glass tube was placed, so that it just touched the top of the bill. The animal, when left perfectly free, remained gazing fixedly at the glass tube for more than a minute. The same thing happened when a cork stopper was used, instead of the glass tube.

Finally, I will mention that with the hens I often hung a piece of twine, or a small piece of wood, directly over their crests, so that the end fell before the eyes. I mention this experiment especially, because, when performed, the hens not only remained perfectly motionless, but closed their eyes, and slept with their heads sinking until they came in contact with the table. Before falling asleep, the hens' heads can be either pressed down or raised up, and they will remain in

this position as if they were pieces of wax. That is, however, a symptom of a cataleptic condition, such as is seen in human beings under pathological conditions of the nervous system.

After I had discovered the events which I have just communicated to you concerning the hens and pigeons, two things were clear to me: 1. That the drawing of the chalk-line in Kircher's experiment was of some significance. The hand which draws the line, and the line itself, are transferred to an object in which the animal's look and attention are placed, through which a marvelous condition of certain parts of its nervous system is called forth, accompanied by cataleptic phenomena, and which can change to sleep.

2. That it produces soporific phenomena in animals, as has long been conjectured, but, until now, never investigated or proved; a peculiar and mysterious state, resembling sleep, accompanied by cataleptic appearances and a change in the nervous system. This can be produced in many men by a simple fixing of the look on some small object, and through a concentration of the will.

It is well known that, in the year 1851, Mr. Braid, a Scotch surgeon, established in Manchester, who was present at the mesmeric exhibitions of Lafontaine, was first struck with the idea that these phenomena, proclaimed as the effect of a magnetic fluid, were only a natural consequence of the fixed look and entire abstraction of the attention, which present themselves under the monotonous manipulation of the magnetizer. Mr. Braid proved in his experiments the entire dispensableness of a so-called magnetizer, and his supposed secret agents, or fluids, produced through certain manipulations; he taught the subjects of the experiments to place themselves in this sleeping condition, by simply making them gaze fixedly at some object for a long time with strict attention and unmoved gaze. It is therefore clear that this condition of the nerves, caused by the steady look and attraction of attention, in one part of the brain, brings the other parts into action with it and changes the functions, to whose normal activity the phenomena of the will are united. This is the actual, natural, physiological connection of this mysterious appearance. It only remains to us now to ascertain which portions of the brain first and secondly become altered, and in what these changes consist.

According to Braid, for example, on one occasion, in the presence of 800 persons, ten out of fourteen full-grown men were placed in a sleeping condition in this way. All began the experiment at the same time; the former with their eyes fixed upon a projecting cork, placed securely on their foreheads; the others, at their own will, gazed steadily at certain points in the direction of the audience. In the course of ten minutes the eyelids of these ten persons had involuntarily closed. With some, consciousness remained; others were in catalepsy, and entirely insensible to being stuck with needles, and others, on awakening, knew absolutely nothing of what had taken place during their

sleep. Even more; three persons of the audience fell asleep without Braid's knowledge, after following the given direction of fixing their eyes steadily on some point.

Braid's experiments, which are designated as the beginning of a scientific investigation of extremely complicated nervous phenomena, did not find at first the esteem and homage due to them, and gradually sank into oblivion. This is explained by the fact that they were associated with mesmerism; and Lafontaine, whose "magnetic" exhibitions were the first cause of Braid's investigations, protested, not without some animosity, that "hypnotism," or "Braidism," was identical with *his* "mesmerism." Braid himself, in the course of his experiments, seems to have lost his former scientific force as an investigator. Then, in 1848, Mr. Grimes, the American, with his "Electro-Biology," appeared, and took up the intellectual epidemic of mediums and spiritual apparitions, which we witnessed in astonishment, and saw the whole world more or less impressed by it. It was, naturally, then, not at all surprising that hypnotism, or Braidism, remained almost unknown to science. Only once it attracted scientific attention and interest, and then only for a short time. This was in 1859, in December, after Velpeau and Broca, two well-known French surgeons of *La Société de Chirurgie*, in Paris, caused the most immense sensation by placing twenty-four women in a sleeping condition by Braid's method, and then performing surgical operations without causing them the slightest pain.

Then much was said in the journals about "hypnotism" in hens, the description of which had already been found in one of Father Kircher's works. Although characteristic enough for those days, yet, to my knowledge, no one has been much impressed by the investigation of Kircher's *experimentum mirabile*, for it treats of a real state of hypnotism; and, with animals, every one feels safe from all thoughts of deception, but yet can bring into application all physiological means of investigation, in order to penetrate the mysteries of the phenomena. *This proof of the actual appearance of hypnotism in animals is the scientific result of my above-communicated observations and experiments*, which I intend to continue upon mammals, on which I have not yet experimented.

These, however, have still another interest for us. They have strikingly demonstrated how difficult it is to obtain actual facts from "events viewed unequally." They have still further shown us what insight, what strength of demonstration, and sharpness of criticism, scientific investigations demand; and, finally, they have made known to every discerning person how little weight should be attached to the reports of the most honorable and upright people, when these people are not entirely penetrated with the idea of the exact nature of the investigation.

This never-to-be-neglected foresight, in the estimation of reports

and testimonies relative to such actual phenomena as appear to exceed the usual events of Nature, is especially justified when, in the sleeping condition of the animal, every trace of visible deception is removed; how much more so are doubt, reserve, and refusal, an irrefragable law and duty, when it treats of phenomena which, on one hand, are a scorn to science, and, on the other, not only give rise to suspicion, but are an actual visible deception! This last double character marks thousands of phenomena which eyes and ears have considered real in mesmerism, clairvoyance, spiritualism, etc.

In the mean while, strict natural science never decides *a priori*, and the indicated character would never prevent science from drawing phenomena of such a character into the range of its investigation and trial. And yet, the science of our day is placed, in every respect, opposite to spiritualism and its relations. Are not the passionate complaints and reproaches to which the representatives of science, and even science itself, are exposed, from the countless fanatics and believers of this mysterious faith, quite unjustifiable?

By no means! It will be easy, after all you have seen and heard here, to justify the bearing of science. I considered myself unable to withdraw from this ungrateful task, because it is a duty of my especial profession to prepare a true explanation, and because my previous scientific research has led me to the region where superstition, prejudice, credulity, and even worse, absolutely rule. I called the task "ungrateful," because one finds powers in opposition against which, as Schiller says, "the gods themselves struggle in vain."

They who are occupied with the questionable regions, which are made attractive and ensnaring through wonderful and mysterious things, are divided into two classes. The first is formed of persons who care nothing about the confirmation and investigation of remarkable events, but, on the contrary, occupy themselves with those events through sordid but harmless motives. To this class belong the frivolous, and those professionless people who are influenced by vanity, and endeavor to kill time with apparently great industry. Of this class it is not necessary to speak further.

The other class is composed of upright people, who mean honestly; and these have a right to be looked after, and set properly on their course, even if teaching and advice find deaf ears.

In this class are two distinct groups: 1. Good people, but bad investigators; that is, the scientific know-nothings, who have never occupied themselves particularly with natural researches, and their results and methods; 2. Scientific people by reputation, who have performed, for their own special departments, real services for science.

Of those who belong to the first group of this class, and who, without profession or special education, undertake to explore such complicated and puzzling events, we can simply say: If these true-hearted people only had an idea of the requirements and difficulties

of an exact natural investigation, a slight comprehension of the strength of the proof which science must absolutely command, if it treats of the confirmation of events, and the connection of the simplest circumstances, they would entirely cease from their senseless and fruitless endeavors, and seek to acquaint themselves with the valuable acquisitions of to-day's teachings, without which man —comparable to a ship without a compass or rudder—tossed about on the sea of error and deception—can be perplexed to imbecility! The excellent advice to keep at a distance all mysterious and supernatural manifestations, in spite of their charms and attractions, has already been communicated to you. An instructive maxim says, "There is a virtuous spirit of relinquishment in intellectual as well as in moral power." And here, in order not to be led into temptation, men must carry this relinquishment to the extreme of intellectual "teetotalism." It is more difficult to deal with the second group of this class. It is clear that if the few natural investigators who compose this group were not entirely divested of the spirit of strict research which they may once have possessed, they would have found ways and means to confirm, in a scientific manner, the "events viewed unequally" which they are not ashamed to testify to as though they were actual circumstances, so as to win the confidence and esteem of all natural investigators. As they have by no means succeeded in this, the weight of their testimony sinks, in spite of its truth, to the level of that of the unlearned persons mentioned in the first group of this class.

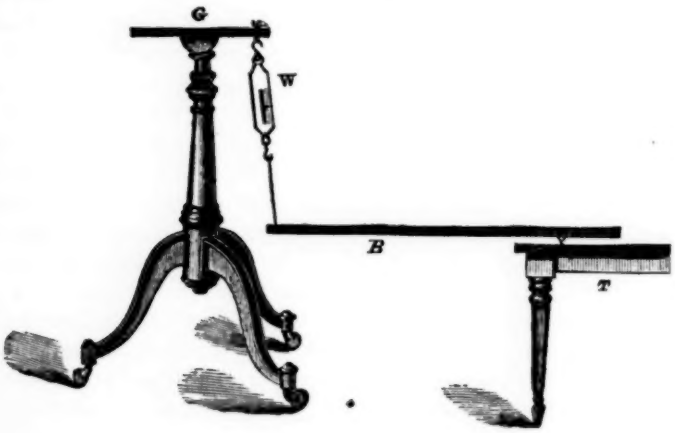
In reference to the perception and knowledge of natural events one cannot vote, *per majora*, as in human laws. The votes here must be weighed. However, to give no opportunity for misconstruction, I will say, beforehand, that the natural investigators of whom I speak have not lost all their weight and respectability in science because they vouched for the reality of unheard-of and absolutely incredible events, but because of the foundation on which they placed this testimony.

They refer us triumphantly to the "scientific" investigation of a Hare, a Crookes, a Butterow, and other well-known "natural investigators!" However, he who examines this startling literature, will only become more confirmed in his ideas. The way alone in which these "investigators" perform their experiments, and the manner in which they make their reports, prove very clearly that they are really no investigators at all. To give one striking example, Crookes announces earnestly to the scientific society of London, of which he is a member, that he has discovered a new feature in Nature, which he calls "psychic force." Through the influence of this force, according to Crookes, the weight of a body can be increased or diminished several pounds, without visible interference!

And how do you think Crookes has investigated and estab-

lished this marvelous circumstance? You will hardly deem it possible, when I tell you he did it simply by noticing, in the presence of certain people, that a spring-balance, of the same kind as one uses to weigh letters, gave movements the causes of which were not apparent.

I will here show you a small drawing, so that you may understand



it better, which illustrates the principle of an apparatus used by Crookes. *B* is the strong mahogany board, several feet long, one end of which rests on the table, *T*, by means of a sharp point placed in the under side, while the other end is fastened to the balance, *W*, which hangs suspended from a rest, *G*. The index of the balance shows how great the weight is which it has to bear. Every movement backward or forward, any shaking or pushing which is communicated to the board, must be made perceptible through a rising or falling of the index. And now, Crookes assures us that he has perceived such motions of the index, in the presence of others, when Mr. Home, the principal medium, did not move the apparatus at all, but was held firmly by the hands and feet, some distance from it! And that is all! Crookes ventures his monstrous assertion on the ground that the balance made motions which appeared to have no cause whatever! Whoever is satisfied with the general assertions of Crookes, in this respect, manifests such incapability of judgment concerning science, that he has simply no right to speak about such things.

That a balance makes motions is a circumstance very easy to establish. We can accept it, as an actual event in Crookes's evidence, that the balance has really made some motions in the presence of the so-called mediums; but when Crookes represents as an actual event that it was the "psychic force" of the medium which caused this motion, and altered considerably the weight of the body, it is, in spite of all persuasion, no real circumstance, but a well-meant assertion of an "event viewed unequally;" a statement which does not deserve the

slightest belief nor the smallest amount of consideration. This assertion does not deserve the latter, simply because it concerns an "event viewed unequally" (for there are many events in this category which deserve the highest esteem), but because the admissible part of Crookes's statement is in itself worthy of no notice, and because not the slightest proof is furnished that the motions only proceeded from the so-called medium, and that they could partake of no heretofore well-known natural cause!

Had such a proof been undertaken in an exact manner, Crookes's assertions would probably have deserved some notice, which would have led to a repetition of his experiment, in order to test more thoroughly his "event viewed unequally;" if this proof had been strictly enforced, Crookes would have discovered one of the most remarkable known events, and his assertions would have at once commanded the utmost respect and consideration from all natural investigators; as, perhaps, with Volta, when he built his pile, which presented no less incredible appearances! But, as the events stand, Crookes's statements, as with hundreds and thousands of "events viewed unequally," concerning moving tables, flying guitars, self-playing pianos, etc., have been regarded with exactly the same claim to science as the best and most astonishing sleight-of-hand performances, which no one can admit to be real natural investigations, although in a psychological respect the real cause of the deception may be very interesting.

Little as it may affect a reasonable man, not to be able to investigate some pretty and striking conjuring trick, so also no one ought to disquiet himself on account of events which hundreds of people have testified to, even when the slightest proof is unproduced, so that every thought relating to the possibility of such an interesting natural phenomenon is removed.

Only through the idea that the phenomena are not visible do these latter present a most remarkable significance in the eyes of the unlearned. But, in this significance, they make no difference between it and conjuring, which is often much more interesting and not less inexplicable. But do they make a distinction in any other respect? As to that we will ask, at first, a little information from the "spiritualists," "natural investigators," and "*savants*," such as Varley, Wallace, Crookes, Butterow, and others, before we allow them the right to make the slightest reproof concerning science, and the dependence of these things upon it.

These gentlemen have not the shadow of a right to complain of any thing save their own incapability, nor have they the right to make a reproach to any one except themselves, that they did not succeed in establishing their "spiritual manifestations."

I will expressly emphasize the fact that I did not say that one must regard all phenomena, which occur daily, and which are of the greatest significance and importance, as mere conjuring-tricks, al-

though numbers of them could be proved to be such. Remember the Davenport scandal! For me, the first "manifestations" are entitled to as little consideration as the latter, and I selected the best authenticated of them when I communicated Crookes's experiments as a characteristic example of "spiritual" literature to the well-known English *savant*, the deserving scholar, our great chemist Hoffman, of Berlin, formerly of London. And has any one of the gentlemen who are "investigators" in this department said any thing to the credit of the deceased American chemist and "spiritualist," Dr. Hare? Does not one find in the literature which they have the assurance to refer us to, accompanied by brainless chattering and fanciful effusions, nothing, nothing at all, but childish or idiotic arrangements, supposed to represent a psychological apparatus, and more or less creditable reports as to the reality of "events viewed unequally?"

In the mean while, you may properly ask if these events, which have been witnessed by hundreds of worthy people, are needful of scientific examination and proof, and whether they are worth it? Oh, yes; but not all, and not in a very high degree. Science and its followers have the right to consult their own time and opportunity. They have something more to do than to occupy themselves in answering every question put to them. You all know the old saying relating to the fool and the seven wise men. That which is worthy of no earnest investigation, and which, nevertheless, can awaken esteem and confidence, in spite of all singularity, should raise no claim to consideration on the part of science. In this case, however, the moving tables, flying guitars, mysterious rappings, of course take no part.

The clamors of hundreds and thousands of eye and ear witnesses who triumphantly hint at "scientific investigations," but who are incapable of giving any proof of the experiments, do not change the matter in the least. Whether one or another investigator may consider these things, is entirely dependent on his personal opinion, and on casual circumstances. Whoever has no opinion on the matter, and holds aloof from it, cannot meet with the slightest reproach. My highly-esteemed friend Prof. Sharpey, who formerly was secretary for many years of the Royal Society of London, was perfectly right when he refused Mr. Crookes's invitation to be present at his experiments with Mr. Home; indeed, he acted with great wisdom, for spiritualists and fanatics are very much inclined to trumpet forth men of science as important witnesses on such occasions. The letter of the celebrated astronomer Huggins, written on the 9th of June, 1871, to Mr. Crookes, is nothing but a polite though decided denial of his opinion relative to different phenomena which had taken place in Crookes's house in Huggins's presence. And yet, this letter is quoted triumphantly, and Huggins, probably much against his will, is considered, from all sides, as one of the "scientific authorities" who

had delivered their testimony as to the reality of spiritual writings, supernatural manifestations, etc. Judge for yourselves! For the preservation of Huggins's honor, and as a striking example of these gentlemen's proceedings, I feel necessitated to communicate this doubtful letter to you:

MR. CROOKES: UPPER SUILSE HILL, *June* 9, 1871.

DEAR SIR: The proof-sheets which you sent me seem to contain a correct representation of what took place in your house in my presence. My position at the table did not allow me to witness the removal of Mr. Home's hand from the piano; but this is considered by you, as well as the person sitting on the other side of Mr. Home, to have taken place. The experiments show me the importance of further investigation. I, however, wish it distinctly understood, that I express no decided opinion in regard to the phenomena.

Your obedient servant, WILLIAM HUGGINS.

Yet, as we have said, whether one or another scientific investigator examines these things, his personal opinion is entirely dependent on the circumstances. But, in regard to strict science, they simply do not exist at all. Science neither recognizes nor denies them; it simply ignores, and it has a perfect right to do this, because time and work are too precious to be wasted on phenomena which can offer no higher interest than that their causes are not apparent — exactly in the same way as with conjuring. In these days, no one is accused of possessing supernatural power, otherwise we might again begin to burn people for heresy and witchcraft. Heretofore, nothing has compelled us to suppose spiritual manifestations and dubious phenomena to be supernatural, and therefore the whole thing is probably not worth any consideration whatever, except perhaps in a psychological point of view.

The absolute opposition of science to spiritualism, etc., is entirely justifiable, as you, gentlemen, must admit, little as you may be satisfied with our views, or much as you have been deceived in your expectations. I can only say that, possibly in consequence of the long reserve of science, much, perhaps, to the harm of mankind, remained, and still remains, undiscovered; for one, with the modesty to which a natural investigator, more than any other else, is forced, can say with Hamlet: "There are more things in Heaven and earth, Horatio, than are dreamt of in your philosophy!" In the mean while this must be borne with. The right time will come for every discovery and every step of progress.

THE SURVIVAL OF INSTINCTS.

By ELIAS LEWIS, Jr.

ANIMAL life has its episodes, and apparently abnormal habits. A gentleman, residing near this city (Brooklyn), had recently a turkey tethered with a cord in a field during the early life of her brood. He had also several other turkeys with which this one had a long time associated, apparently on the most friendly terms, and which, during her temporary confinement, strolled and fed quietly around her. But it happened one day that she became entangled with the cord, so that her feet were drawn together, and, being unable to walk, lay struggling on the ground. While thus helpless her associates attacked her, evidently for the purpose of killing her outright. They made no onset as when fighting, but deliberately and in the coolest manner possible commenced their butchery by picking the head of the unfortunate bird.

So intent were they that they scarcely heeded the approach of our friend, who, from a distance, saw what was going on. Before he reached the spot, the assailants had destroyed one eye and laid bare the skull, inflicting injuries so great upon the creature that she soon died. A similar act was repeated shortly afterward in the same flock, and the phenomenon—certainly a curious one—is, we believe, not unusual.

Observation and inquiry have shown that a like disposition appears not among turkeys only, but in several species of animals, exciting them, when aroused, to attack and worry those of their kind if weak, sick, or disabled. It has been noticed with cattle, swine, dogs, and, as has been suggested by observers, may occur with all domesticated or partly domesticated species in which it had existed in their wild state. We are informed by drovers, of whom we have made careful inquiry, that when herds of cattle are hurriedly driven, and especially when they become excited or alarmed, one having fallen, or showing signs of weakness, is sometimes set upon and gored by its associates.

Two gentlemen, who have been drovers forty years, and during many years were themselves collectors and drivers of herds, assure us that they have often witnessed such attacks, and have interfered to prevent injury. They also state that the habit appears to be more frequent with animals which have run at large without much care or restraint, than with those well domesticated.

Such occurrences, however, are well known among domesticated cattle. A gentleman residing on Long Island had, a few years since, a herd of cattle, one of which was taken suddenly sick, but was turned, as usual, into the field with the others. In a short time he noticed great disturbance among them, and, on hurrying to the spot, found

the sick one on the ground bellowing, and being gored by her associates. An acute observer, also residing on Long Island, near this city, Mr. J. D. Hicks, writes as follows: "In answer to thy inquiries, J. H. and S. R. inform me that the fact has been noticed in their own experience that the well ones of a herd do sometimes seek to gore and destroy a sick or maimed one. A cry of distress, instead of exciting sympathy, seems to invite attack, and the first movement by one is a signal for attack by others. Thee may rest perfectly assured of this. I have myself more than once witnessed it."

The gentlemen whose initials are given are large owners of cattle, and have for nearly half a century been familiar with their habits, and with the habits of those brought in droves from distant parts of the country. Of the habits of entirely wild cattle we know but little. The wild herds of the pampas have descended from tame stock, and it is not easy to show by instances the habits of the original wild stock in this particular. A breed of cattle formerly common in Southern Scotland, noted for their untamed and savage disposition, is spoken of by Cuvier, under the name of white urus, and he says: "When one of this breed happens to be wounded, or is enfeebled by age or sickness, the others set upon it and gore it to death."

With swine a similar habit has been observed. We are informed that it is sometimes necessary to separate disabled ones, for safety, from the general herd. The drovers already referred to state that, in the driving and transportation of swine, those which become sick and faint are often objects of attack. Drooping of the ears, and other evidences of exhaustion, seem to excite the propensity, and may occur while being driven, or in pens in course of transportation. In cars, where they are probably much excited, weak and fallen ones are often torn to pieces, and sometimes devoured.

On one occasion, after a sick pig was thus disposed of, a dead dog was thrown among the excited animals, but no notice was taken of it. We will mention, in this connection, that we have not learned of any instance of an animal, strong and vigorous, being thus attacked, nor where a sick or feeble one was defended by its associates when such an attack was made; and it is certain that with hogs, as with cattle, the more untamed they are, the more violent and savage is their disposition, and the more frequent the peculiar habit we have under consideration.

Audubon observes that, with the wild-turkey, the old males, on their marches, frequently destroy, by picking the head, those which are immature, but it does not appear that full-grown and vigorous birds are attacked. The old, sick, and disabled, are continually left to their fate by moving herds of the American bison, and are fed upon by wolves. That they are expelled by violence is probable, but, so far as we know, there is no positive proof of the fact. It is known that wolves, if wounded, are attacked and killed by their comrades;

and the arctic fox, if disabled, is sometimes not only destroyed, but eaten by its companions. One of a school of porpoises at play around a vessel, as we once witnessed, was injured by a pole hurled at it, when it was instantly pursued by dozens of others with a celerity of movement that was astonishing.

Darwin, commenting on this trait in animals, says: "It is almost the blackest fact in natural history that animals should expel a wounded one from the herd, or gore or worry it to death."

That the helpless and suffering should be thus destroyed does indeed seem to indicate an absence of sympathy in strange contrast with the kindness and affection shown in innumerable instances between animals of the same species. But the kind-hearted author already cited remarks that "instinct or reason may suggest the expelling an injured companion, lest beasts of prey, including man, should be tempted to follow the troop. In this case their conduct is not much worse than that of the North American Indians, who leave their feeble comrades to perish on the plains, or the Feejeeans, who, when their parents get old or fall ill, bury them alive."

If the view of Darwin be correct, it is evident that the habit originated in the wild and undomesticated state of the species, and that, in destroying their disabled or wounded ones, they simply act out their instinct of self-preservation.

They get rid of those which might delay their flight or allure pursuit; and we may conclude that love of life and fear of danger, rather than any primal ferocity, develop and fix a habit which at first sight appears singular and unaccountably savage.

Animals in their wild state live in perpetual danger, and, we may add, in perpetual fear. Sir John Richardson observes that wolves continually haunt the track of the buffalo, and the weak are often seized. The peccary, says Cuvier, if it falls in the rear of the flock, is seized by the jaguar, and the feeble, straggling ones of every herd become a prey to its enemies, and incite pursuit. It would be strange, indeed, if this source of danger, so obvious and persistent, should escape the sagacity of animals, or be disregarded by their prudence. We know that animals of many kinds defend each other, and thus protect themselves. The habit referred to is merely a method of defense. The courageous and strong stand guard over the herd or flock in time of danger, and the intelligence or instinct which prompts this also prompts the removal of an element of weakness.

Nor do animals differ in this respect from man. Does history furnish no instances where commanders of armies have sacrificed the wounded, and destroyed by poison or otherwise the weak and helpless that the strong might escape destruction? Equally with animals and with man, danger may suggest and put in execution means for securing safety, which show a strange absence of sympathy in the one case, and of humanity in the other.

It is not probable that animals possess savage qualities other than such as are or were originally of service to them and their kind. We cannot understand that any quality or habit should be developed in an animal which was not serviceable to it; but it is certain that both may arise from the wants and necessities incident to its condition.

If strength and fleetness are essential in pursuit, so also is sagacity in eluding it. An element of danger is detected and removed. A fox will use every precaution that the hound may not be allured by his odor, and the white urus destroys its weak comrade which falls in the rear unable to maintain its place in the flight. The habit with some animals of destroying their weak companions is only one of many which by repetition becomes at last common to the kind. With the repetition of the act grows a disposition or tendency to repeat it as the exciting cause or condition recurs. It becomes thus in the creature a tendency which we may term instinctive, and that such tendencies are transmissible and are inherited needs no illustration here. Perhaps there is no fact in biology more clearly established and more fearfully significant than this, and it is true equally in man and in the lower animals.

Habits thus developed do not readily disappear, but the old disposition or instinct may remain after the habit has been discontinued, and long after it has ceased to be of service to the creature. This is shown by the fact that former habits frequently reappear when suggested by former predisposing conditions, although these may have been long overlooked or forgotten.

Under domestication many habits indispensable to animals in their wild state become useless, and slowly but surely disappear, while others are developed, and the animal undergoes a physical and mental change; but the time is very long before old instincts die out beyond the possibility of resuscitation. They appear to continue in animals under domestication as do those of the savage, in civilized life, despite culture and education. We will illustrate by a single instance:

With the savage, hunting is the occupation of life. He hunts from necessity, and his mental, moral, and physical being, are attuned to its conditions. His hunting habits and hunting dispositions are thoroughly instinctive, but in civilized communities the necessity for hunting has chiefly disappeared. Still, the field and forest are hunting-grounds. The savage is not there, but who will say that the old instincts have not survived in the cunning of pursuit, the thoughtless cruelty of destruction, and indifference to suffering? It is true our modern hunter has grown gentle, humane, and tender, in a thousand directions, but the enjoyment of him who hunts merely for sport cannot be in that spirit which has developed with his culture—which weeps at the sight of agony, and is tender to the "mournful eloquence of pain."

We refer to this only to illustrate the persistence of instinctive

tendencies, and of the habits with which mental states seem directly associated.

It is, we believe, probable, perhaps certain, that the disposition in some animals to destroy their weak associates has come down from a former undomesticated condition of their kind, in which its correlative habits were essential to safety and life.

If this view be correct, our friend's birds may not be obnoxious to the charge of being specially cruel; and, seeing how persistent instinctive habits may become in some of the higher animals and in man, it is not strange that they continue in the turkey, a species recently domesticated, and by no means remarkable for intelligence.

THE PRIMARY CONCEPTS OF MODERN PHYSICAL SCIENCE.

By J. B. STALLO.

II.—*The Atomic Constitution of Matter as a Postulate of Thought.*

MY inquiry thus far has touched the assertion according to which the atomic hypothesis is the necessary basis of the theories which constitute the sciences of physics and chemistry. I propose now to consider the claim that this hypothesis is an essential prerequisite of the realization of material existence in thought.

To show how pointedly this claim is made, it will be sufficient to extract a passage from a recent lecture of Prof. John Tyndall, before the British Association at Liverpool, "On the Scientific Use of the Imagination" ("Fragments of Science," American edition, p. 135). The words of Prof. Tyndall, whose opinions, by reason of his eminence among physicists, may be taken *instar omnium*, are these:

"Many chemists of the present day refuse to speak of atoms and molecules as real things. Their caution leads them to stop short of the clear, sharp, mechanically-intelligible atomic theory enunciated by Dalton, or any form of that theory, and to make the doctrine of multiple proportions their intellectual bourn. I respect the caution, though I think it is here misplaced. The chemists who recoil from these notions of atoms and molecules, accept without hesitation the undulatory theory of light. Like you and me, they one and all believe in an ether and its light-producing waves. Let us consider what this belief involves. Bring your imagination once more into play, and figure a series of sound-waves passing through air. Follow them up to their origin, and what do you there find? A definite, tangible, vibrating body. It may be the vocal chords of a human being, it may be an organ-pipe, or it may be a stretched string. Follow in the same

manner a train of ether-waves to their source; remembering at the same time that your ether is matter, dense, elastic, and capable of motions subject to and determined by mechanical laws. What, then, do you expect to find as the source of a series of ether-waves? Ask your imagination if it will accept a vibrating multiple proportion—a numerical ratio in a state of oscillation? I do not think it will. You cannot crown the edifice by this abstraction. The scientific imagination, which is here authoritative, demands as the origin and cause of a series of ether-waves a particle of vibrating matter quite as definite, though it may be excessively minute, as that which gives origin to a musical sound. Such a particle we name an atom, or a molecule. I think the seeking intellect, when focussed so as to give definition without penumbral haze, is sure to realize this image at the last."

The import of these sentences is plain. It is that an ethereal or other atom, or a molecule, is related to its vibratory motion just as any ordinary body is related to its movements of translation—as a stellar or planetary body, for instance, is related to its movements of rotation or revolution; and that, just as the conception of the stellar or planetary body of necessity precedes the conception of its rotary or revolutionary motion, so also the conception of the atom or molecule of necessity precedes the conception of the vibratory motion whereof light, heat, electricity, chemical action, etc., are known or supposed to be modes. In other words: to make the existence of matter, such as we deal with in action and in thought, conceivable, we are constrained, according to Tyndall, to assume ultimate material particles as pre-existing to those motions or manifestations of force which are apprehended as light, heat, electricity, chemical action, etc.

In order to preclude all possibility of misunderstanding, it is perhaps well to call attention to the fact that, while Tyndall speaks in terms only of the relation of the ether to its vibratory motion, it is evident from his own language that this is meant as an illustration or exemplification of the relation of all matter to any or all motion whatever.

Now, let us for a moment contemplate an ultimate particle of matter in this state of existence in advance of all its motion. It is without color, and neither light nor dark; for color, lightness, darkness, etc., are luminar affections, and, according to the received mechanical theory of "imponderables," of which Prof. Tyndall is a distinguished champion, simply modes of motion. It is similarly without temperature—neither hot nor cold; for heat also is a mode of motion. For the same reason it is without electrical or chemical properties—in short, it is utterly destitute of all those properties in virtue of which, irrespective of its magnitude, it could be an appreciable object of sense, unless we except the properties of weight and extension. But weight is a mere play of attractive forces; and extension, too, is known to us only as resistance, which in turn is a manifestation of force, and thus a phase of motion. Extension *per se*, abstract extension, cannot

be realized in thought, whatever ground there may be for dissenting from the opinion of Sir W. Hamilton ("Lectures on Metaphysics," Boston edition, p. 385), that "we cannot represent extension to the mind except as colored."

Thus the solid, tangible reality, craved by Prof. Tyndall's "scientific imagination," wholly vanishes from the "seeking intellect" the moment this intellect attempts to grasp it apart from the notion which is said to presuppose it as its necessary substratum. If the deliverances of the scientific imagination are authoritative in science, the notion of the primordial atom must be relegated to the regions beyond the bounds of scientific thought.

There is another and very obtrusive aspect of the atomic theory in which its utter inability to satisfy the demands of the "scientific imagination" has long since been recognized. As I have already shown, the atomic theory, in whatever form it is held, presupposes the separation of the atoms by void, interstitial spaces. The only difference of opinion respecting these spaces is as to their magnitude, the emergencies of the modern theories of heat and light having led to the supposition that even in the case of the purely hypothetical "ether" (which is nothing but a clothes-horse for all the insoluble difficulties presented by the phenomena of sensible material existence—a fagot of occult qualities and *principia expressiva*, whose *rôle* in the material world at large is analogous to the part formerly played by the *aura vitalis*, and similar phantasms, in the organic world) the interspaces are very great in comparison with the dimensions of the atoms, so that a group of these atoms is not infrequently compared with a stellar or planetary system. Nevertheless, their motions are construed as effects of their mutual attractions and repulsions. But how is the mutual action of atoms existing by themselves in complete insulation and wholly without contact to be realized in thought? We are here in the presence of the old difficulties respecting the possibility of *actio in distans* which presented themselves to the minds of the physicists in Newton's time, and constituted one of the topics of the famous discussion between Leibnitz and Clarke, in the course of which Clarke made the remarkable admission (Fourth Letter of Clarke, § 45, "Leibnitii Opera," ed. Erdmann, p. 762) that, "if one body attracted another without an intervening body, that would be, not a miracle, but a contradiction; for it would be to suppose that a body acts where it is not"—otherwise expressed: inasmuch as action is but a mode of being, the assertion that a body can act where it is not would be tantamount to the assertion that a body can be where it is not. This admission was entirely in consonance with Newton's own opinion; indeed, Clarke's words are but a paraphrase of the celebrated passage in one of Newton's letters to Bentley, cited by John Stuart Mill in his "System of Logic," which runs as follows:

"It is inconceivable that inanimate brute matter should, without

the mediation of something else, which is not material, operate upon and affect other matter *without mutual contact*. . . . That gravity should be innate, inherent, and essential to matter, so that one body may act on another, at a distance, through a vacuum, without the mediation of any thing else by and through which their action and force may be conveyed from one to the other, is to me so great an absurdity that I believe no man, who in philosophical matters has a competent faculty of thinking, can ever fall into it."

The thesis of the impossibility of *actio in distans* has been a standing dogma among physicists ever since the revival of physical science, three centuries ago. Twenty-five years before the publication of Descartes's "*Discours*," it found expression in the axiom of Bartholomew Keckermann ("Systema Physicum," Hanau, 1612): "Omnis alteratio fit per contactum;" and Descartes's whole physical system had its root in the proposition that "a body can no more act *where* it is not than it can act *when* it has ceased to be, the principle, *cessante causa cessat effectus*, holding good in either case." It was this "patent absurdity" of material action through empty space which led the greatest mathematicians of Continental Europe (the elder Bernouillis, Huyghens, etc.) to reject the doctrines of Newton's "Principia," and induced Leibnitz to construct his system of "cosmic circulations," in which the old Cartesian vortices reappeared in a new dress, and under another name.

The conflict between the theory of distant attraction and the authority of the "scientific imagination" is one of the instances adduced by John Stuart Mill ("System of Logic," book ii., chap. v., § 6) in support of his proposition that conceivability is no test of truth, because it is the simple result of familiarity of thought or experience; and he expresses the opinion that "the majority of scientific men have at last learned to conceive the sun attracting the earth without an intervening fluid, and that "the ancient maxim, that a thing cannot act where it is not, probably is not now believed by any educated person in Europe" ("Logic," book v., chap. iii., § 3). But Herbert Spencer ("Principles of Psychology," ii., 409) justly doubts the truth of this opinion, expressing the belief that "the most that can be said is that they" (the scientific men) "have given up attempting to conceive how gravitation results." How formidable the difficulty under discussion still appears to the minds of physicists at the present day, and how completely the mental predicament of the nineteenth century is identical with that of the seventeenth, is evident from the many recent renewals of the attempt to construe the action of gravity as a case of ethereal pressure or impact. I content myself with the citation of a very characteristic paragraph, written long after the sentences quoted from Mill, in a late article of Prof. Challis "On the Fundamental Ideas of Matter and Force in Theoretical Physics" (*Philosophical Magazine*, § 4, vol. xxxi., p. 467). "There is no other kind of force,"

says Prof. Challis, "than pressure by contact of one body with another. This hypothesis is made on the principle of admitting no fundamental ideas that are not referable to sensation and experience. It is true that we see bodies obeying the influence of an external force, as when a body descends toward the earth by the action of gravity; and, so far as the sense of sight informs us, we do not in such cases perceive either the contact or the pressure of another body. But we have also the sense of touch or of pressure by contact—for instance, of the hand with another body—and we feel in ourselves the power of causing motion by such pressure. The consciousness of this power and the sense of touch give a distinct idea, such as all the world understands and acts upon, as to how a body may be moved; and the rule of philosophy which makes personal sensation and experience the basis of scientific knowledge, as they are the basis of the knowledge that regulates the common transactions of life, forbids recognizing any other mode of moving a body than this. When, therefore, a body is caused to move without apparent contact and pressure of another body, it must still be concluded that the pressing body, although invisible, exists, unless we are prepared to admit that there are physical operations which are and ever will be incomprehensible by us. This admission is incompatible with the principles of the philosophy I am advocating, which assume that the information of the senses is adequate, with the aid of mathematical reasoning, to explain phenomena of all kinds. . . . All physical force being pressure, there must be a medium by which the pressure is exerted."

It is not my purpose, of course, to question the Newtonian doctrine of gravitation, or to urge the adoption of the views of Prof. Challis and others, who seek to show that what seems to be attraction is in reality a propulsion of solid bodies in immediate contact. That the transfer of motion from one body to another by impact is no less incomprehensible than *actio in distans* becomes apparent on a moment's reflection; and that the hypothesis of an intervening "ether"—itself composed of atoms, the interspaces between which are larger in proportion to these atoms than the interstellar spaces—is simply a new presentation of the old perplexity in a worse form, and in no wise helps to remove the difficulties involved in the phenomenon of the correspondence between the movements of two bodies without contact, is equally clear, and has been sufficiently pointed out by Herbert Spencer ("First Principles," p. 59). My object is merely to show that, if the validity of every theory of the constitution of matter is to be tested by our ability to realize it in thought—to bring it clearly before the scientific imagination, to represent it mentally as a distinct image, or whatever may be the form of words in which this requirement is expressed—the atomic theory fails as completely as any other theory of the nature of matter which has ever been propounded.

But what ground is there for the assumption that conceivability is

a test of reality? This question has been the subject of a famous controversy between Dr. Whewell and John Stuart Mill, and of a more recent discussion between Mill and Herbert Spencer. Mill broadly denies that "our capacity or incapacity of conceiving a thing has any thing to do with the possibility of the thing in itself," while Spencer deems it to be a universal postulate of all thought that an inconceivable proposition, i. e., a proposition "of which the terms cannot, by any effort, be brought before consciousness in that relation which the proposition asserts between them—a proposition of which the subject and predicate offer an insurmountable resistance to union in thought"—must necessarily be held to be untrue. My present purpose does not, in strictness, call for a thorough examination of this question; nevertheless, it is desirable that the confusion into which (as is usual in such cases) it has been thrown by the emergencies of the debate should be partially cleared up.

Here, at the outset, it appears to me to be unfortunate that Mill repudiates, and Spencer does not insist upon, a distinction suggested by Coleridge between the *Inconceivable* and the *Unimaginable*, though we may find reason for dissenting from Coleridge's proposition, that "the Unimaginable may possibly be true, but the Inconceivable cannot." It is true, as has been observed by Reid (and after him by Stewart), that "conceiving, imagining, and apprehending, are commonly used as synonyms in our language;" but the distinction above referred to is, nevertheless, both real and important. Mill, indeed, declines to recognize this distinction, not from any deference to the usages of ordinary speech, but by reason of his antagonism to a philosophical system. He is a strict scholastic nominalist, and denies that there are any objects corresponding to concepts in the mind any more than in Nature, for the reason that concepts, being the results of abstraction, are general, while objects can be represented or imaged in thought only as particular. And, having pointed out ("Examination of Sir W. Hamilton's Philosophy," chap. xvii.) that in reasoning we rarely attend to all the attributes of which a concept is said to be the complement, but deal exclusively with more or less of these attributes which we are able to bring separately before the mind by means of names that suggest them, on the principle of the association of ideas, he claims that our reasoning is carried on by means, not of concepts, but of names.

At the first blush, the remark of Sir W. Hamilton, that the war between the conceptualists and nominalists is a mere war of words, would appear to be just. Surely the most inveterate nominalist must admit that the material of our reasoning processes consists, not of the sounds or written symbols composing words, but of the meanings which underlie them. And, roughly stated, concepts are nothing but these meanings. If a concept be, in the language of Sir W. Hamilton, a "bundle of attributes"—as for purposes of discursive reasoning it

undoubtedly is—then every increase or diminution of this bundle is in effect the formation of a new concept; and Mill's objection that we cannot think by means of concepts, because in reasoning we bring before the mind a varying number of the attributes composing them, is seen to be founded on the mistaken assumption that for every object there is but one corresponding concept, the truth being that an object may be represented in thought by concepts without number. For every object is the first link in innumerable chains of abstractions varying in kind and diverging in direction with the comparisons instituted between it and other objects; and each of the links beyond the first is a concept under which the object may, in scholastic phrase, be subsumed. A horse, for example, may be considered *mechanically* as a system of levers and strings, a self-regulating locomotive, a machine, etc., or as a thousand pounds moving at the rate of 2.40 per mile, a heavy body, etc.; or, *chemically*, as a congeries of calcium and magnesium phosphates, carbonates, and fluorids, with albumine, fibrine, and similar substances, as a compound of oxygen, hydrogen, carbon, nitrogen, sulphur, phosphorus, calcium, magnesium, silicon, etc.; or, *zoologically*, as a solipede, an ungulate, a mammal, an animal, etc.; or, *economically*, as a beast of burden, a domestic animal—and so on, indefinitely. The formation of concepts like these is incident to all productive reasoning about individual things, and their fixation by means of language (speaking of language in the comprehensive sense of all symbols by which forms of thought may be represented) an indispensable condition of the progress of scientific knowledge, or, indeed, knowledge of any sort.

On the other hand, the most obstinate conceptualist will not deny that, before any one of these concepts can stand as the representative of an actual, concrete object, it must be supplemented with all those circumstances of singularity or particularity which were left behind in the progress of abstraction.

On closer examination, however, the war of words between Mill and his antagonists proves to be a real contest of principles. The elaboration of the data of experience into concepts implies an establishment of relations between these data in conformity to laws not immediately derivable from this experience itself—a mental digestion of the crude material of sense; and this is, in Mill's opinion, inadmissible in view of the purely sensational origin of all knowledge. Mill has an instinctive horror of every thing which purports to be something else than a deliverance of sense, and contends that in our thought we are at all times conversant, not with abstractions, but with facts. Whether this be true or not, depends upon the meaning of the word "facts," irrespective of the necessary reservation that all the facts about which we know any thing at all are the facts of consciousness. A satisfactory discussion of this topic (to which very valuable contributions have been made by Mr. Ferrier) is beyond the scope of my inquiry;

it is sufficient for my purpose to have it conceded that in thought, properly so called, i. e., in those intellectual operations in which the deliverances of sense are digested into that system of ideal forms and relations which we call knowledge, or (what is the same thing) science, we never deal with things as they exist, or are represented as existing, objectively—that we have not, nor can we have, present to our minds the whole complement of phenomena which are the constituents of a material object, but always some one or more of them selected or "abstracted" from the rest; that being so, not only for the reason that all our thought is, in the language of Leibnitz (adopted by Herbert Spencer in the first chapter of his "First Principles"), symbolical, the attributes even of the simplest material object being too numerous to be represented in consciousness at the same time, but for the far weightier reason that our knowledge of the attributes of a material object is never complete. I may say here, incidentally, that, in asserting the abstract nature of thought, I am not taking sides in the interminable controversy between Realism and Idealism, or Presentationism and Representationism; a controversy which would be speedily ended if it came to be thoroughly understood that the phenomena of vision, which, ever since the time of Plato, have furnished nearly all the metaphors for the description of intellectual operations, present but distant analogies of the phenomena of perception, and that the puzzle about mediate and immediate perception is but the common case of the obscuration of a subject by a series of figures meant to illustrate it. In my discussion, I am only generally concerned with the fundamental relation which all our thought about objective reality bears to that reality itself.

There is, of course, no agreement among thinkers as to the nature or even the number of successive steps which lead to the formation of the elements of distinct thought. The terms most commonly employed of late (by those, at least, whose authority commands the most respect, viz., the comparative philologists, who are constrained, by the methods of their own science, to treat psychological questions inductively), to designate those steps, are Sensation, Perception, Representation, and Conception. The first two of these I shall, for the moment, leave wholly out of the account, as not relevant to the present inquiry, it being admitted on all hands that the materials of distinct thought are either representations or concepts. A representation may be generally defined as an exhibition to the mind of the deliverances of sense (if the object be real, or of the phantasy if the object be imaginary), in their empirical order and form—in other words, as a mere mental image of the object; while, in the concept, these deliverances are reduced to unity by the establishment of relations between them other than the relation of their fortuitous concurrence, the concept, at the same time, being made distinct by the establishment of relations between it and the previous concepts of the mind. If I were writing a treatise on

logic, or psychology, these definitions would have to be reduced to forms far more precise; but I purposely refrain from an attempt at exact definition, because I wish to remain on ground common to all who have made the matter in hand the subject of their investigation. For my purpose, it is of little consequence whether or not the distinction here indicated between representations and concepts is accurate and clear; nor is it necessary to determine the exact nature of the relations established in conception between the constituents of a concept, or between the various concepts themselves; it is sufficient to know that both in the representation and in the concept we have in some form a complex of attributes which are ultimately, in the case of material objects at least, traceable to sensible experience, and that the elaboration of representations into concepts involves the establishment of some sort of mental relations between their elements, as well as between the several concepts themselves.

At this point, it is important to guard against a confusion which naturally arises from the fact that logicians and psychologists habitually illustrate the evolution of concepts by examples taken from the abstract sciences. There is a very wide distinction between the relation of a concept to the object of thought in mathematics, for instance, and the corresponding relation between a representation, or concept of a material object, to that object itself. In mathematics, as in all the sciences which are conversant with single relations or groups of relations established (and, within the limits of the constitutive laws of the mind, *arbitrarily* established) by the mind itself, all concepts are exhaustive in the sense that they imply, if they do not explicitly state, all the properties belonging to the object of thought. Not only the constituents of such an object, but also the laws of their interdependence, being determined by the intellect, they may be strictly deduced, each from the other.[1] Thus, a parabola is a line, every point in which is equidistant from a fixed point and a given straight line: that is one

[1] The truth of the proposition that the system of forms and relations, whose discussion constitutes the science of mathematics, is of purely subjective determination, does not involve the assumption (erroneously attributed to Kant, who, on the very first page of his "Critique of Pure Reason," expressly draws the distinction between the "beginning of all knowledge *with* experience," and "the derivation of all knowledge *from* experience"), that the mind is furnished *a priori* with ready-made ideas or concepts; nor is it affected by the circumstance that these forms and relations are ultimately referable to the facts of sensible experience. Mill's refusal to recognize this has betrayed him into writing the extraordinary fifth chapter of the second book of his "System of Logic," in which he questions—albeit falteringly—the necessary truth of the propositions of geometry. The inevitable outcome of this is seen in the writings of Mr. Buckle, who not only boldly asserts that there are no lines without breadth (he strangely forgets the thickness), but also that the neglect of this breadth by the geometrician vitiates his conclusions. His comfort is that the error, after all, is not very considerable. "Since, however," is his language ("History of Civilization in England," ii., 342, Appletons' edition), "the breadth of the faintest line is so slight as to be incapable of measurement, except by an instrument used under the microscope, it follows that the assumption, that there

of its concepts. And in this all the properties of the parabola—that it is a conic section formed by cutting a cone parallel to its sides, that the area of any of its segments is equal to two-thirds of its circumscribed rectangle, etc.—are implied, and from it they may be deduced. Each one of its attributes is an implication of all the others. Our concepts of material objects, on the contrary, are never exhaustive, for their complement of attributes varies with our experience concerning them. These attributes are expressive of the relations between the object and other objects; and, the number of objects being unlimited, the synthesis of attributes is, of necessity, incomplete. And the interdependence of these attributes, as well as the connection between the objects themselves, or their representative images and concepts, has its origin in laws, of which the laws of the intellect are but a partial reflex. It is true that the concept of a material object contains elements whose interdependence is subjective (every intellectual operation, or rather its result, being in some form a synthesis of subjective and objective data); but even these are liable to determination by undigested empirical elements which are present along with them. Moreover, our knowledge of the attributes of a material body is not only imperfect, but these attributes are variable. This is obvious enough in the case of those properties which are usually designated as secondary qualities; every one knows that the thermic, optic, electric, or magnetic conditions of a body change at every moment. But, in fact, there is no property whatever, of a material body, which is strictly invariable, or the law of whose variation is fully known. For this reason, also, the concept of a material object can never expressly, or by implication, be a full complement of its attributes.[1]

can be lines without breadth, is so nearly true, that our senses, when unassisted by art, cannot detect the error. Formerly, and until the invention of the micrometer, in the seventeenth century, it was impossible to detect it at all. Hence, the conclusions of the geometrician approximate so closely to truth, that we are justified in accepting them as true. The flaw is too minute to be perceived. But that there is a flaw, appears to me certain. It appears certain that, whenever something is kept back in the premises, something must be wanting in the conclusion. In all such cases, the field of inquiry has not been entirely covered; and, part of the preliminary facts being suppressed, it must, I think, be admitted that complete truth is unattainable, and that no problem in geometry has yet been exhaustively solved."

Whether Buckle was able to think of a line as the limit between two surfaces, and whether, in his opinion, such a limit has breadth (i. e., is itself a surface, so that we are driven from limit to limit *ad infinitum*), he does not tell us. Nor does he say whether or not, in view of the fact that the breadth of a line depends upon the material out of which it is constructed, or upon which it is drawn, there ought to be a pasteboard geometry, a wooden geometry, a stone geometry, and so on, as distinct sciences.

[1] I do not enter into the question whether or not the use of the word "concept," in reference to material objects, can in all cases be justified, and whether the distinction between representations and concepts is not, in many cases, including the case of "singular concepts," so called, very shadowy. In this connection, it is significant that the Germans use the expression "empirical concept" (*Erfahrungsbegriff*), as equivalent to "representation" (*Vorstellung*).

Bearing this in mind, we shall experience little difficulty in determining the conditions under which the representation and conception of a material object as real are possible. A representation of such an object being an exhibition of the deliverances of sense respecting it, it is plain that nothing can be represented as objectively real, except in terms of experience. And, since our experience is only of the singular and particular, it is also evident that a concept cannot be represented in the mind as objectively real. Thus, matter as such is not a real thing, but a concept; it cannot be "realized" in thought. We can realize, or imagine, or represent as actual, only some one particular thing, with all its accidents of particularity—as of particular dimensions, of a particular color, of a particular temperature, and as being either at rest (i. e., in a state of tension) or in motion. All attempts mentally to represent the reality, in and by itself, of any of the elements into which an individual object is analyzed by the process of abstraction are necessarily futile. The history of speculation is full of attempts of this sort—of attempts to grasp the "thing" as distinct from its properties, the substance apart from its attributes, or, conversely, the attributes apart from their unity, the substance. It is this old error which lies hid in the reasoning of Prof. Tyndall in the passage quoted at the beginning of this article. And the same error lurks in Faraday's endeavor to represent matter as a mere complex of forces. In the one case the properties are imagined to be added to the thing, or the attributes are supposed to be implanted in the substance, as the plums are stuck into the pudding, so that the substance will remain after the attributes are removed; in the other case the substance is looked upon as a mere sum of the attributes—the pudding is thought to be all plums, which not only have a reality by themselves, but which are alone real. That this apparently trivial illustration is entirely apposite, is readily shown by a reference to the grounds upon which Faraday rejects the hypothesis of corpuscular atoms. While the advocates of this hypothesis seek to remove the plums and to retain the pudding, Faraday, on the contrary, takes the plums, and then asks, "Where is the pudding?" "What do we know," he says (Tyndall, "Faraday as a Discoverer," p. 123, American ed.) "of the atom apart from its force? You imagine a nucleus which may be called *a*, and surround it by forces which may be called *m*; to my mind, the *a* or nucleus vanishes, and the substance consists in the powers of *m*. And, indeed, what notion can we form of the nucleus independent of its powers? What thought remains on which to hang the imagination of an *a* independent of the acknowledged forces?"

The true root of all these errors is a total misconception of the nature of reality. All the reality we know is not only spatially finite, but limited in all its aspects; its whole existence lies in relation and contrast, as I shall show more at length in the next article. We know nothing of force, except by its contrast with mass, or (what is the same

thing) inertia; and conversely, as I have already pointed out in my first article, we know nothing of mass, except by its relation to force. Mass, inertia (or, as it is sometimes, though inaccurately, called, matter *per se*), is indistinguishable from absolute nothingness; for matter reveals its presence, or evinces its reality, only by its action, its force, its tension or motion. But, on the other hand, mere force is equally nothing; for, if we reduce the mass upon which a given force, however small, acts until it vanishes—or, mathematically expressed, until it becomes infinitely small—the consequence is that the velocity of the resulting motion is infinitely great, and that the "thing" (if under these circumstances a thing can still be spoken of) is at any given moment neither here nor there, but everywhere—that there is no real presence. It is impossible, therefore, to construct matter by a mere synthesis of forces. And it is incorrect to say, with Bain ("Logic," ii., 225), that "matter, force, and inertia, are three names for substantially the same fact," or that "force and matter are not two things, but one thing," or (ib., p. 389) that "force, inertia, momentum, matter, are all one fact"—the truth being that force and inertia are *conceptual constituents* of matter, and neither is in any proper sense a fact. Nor is the ordinary analysis of physical reality into matter + force correct, inasmuch as force is already implied in the term matter. It is an analysis of a thing into two elements, one of which is the thing itself. The true formula of matter is mass × force, or inertia × force.

We now have before us, in full view, one of the fundamental fallacies of the atomic theory. This fallacy consists in the delusion that the conceptual constituents of matter can be grasped as separate and real entities. The corpuscular atomists take the element of inertia and treat it as real by itself, while Boscovich, Faraday, and all those who define atoms as "centres of force," seek to realize the corresponding element, force, as an entity by itself. In both cases elements of reality are mistaken for kinds of reality. It is, therefore, sheer nonsense to speak, with Papillon (see the article on the Constitution of Matter in the September number of this journal, p. 553), of a "bare energy, stripped of its material dress;" of a "force in its purest essence, upon which we look as on the marble of the antique, in splendid nakedness, which is radiant beauty too."[1]

This disposes, in my judgment, of the authority of the "scientific imagination," in all cases where an attempt is made to determine the constitution of matter. In respect to the general question, however, whether our ability to imagine a thing is decisive of its possible reality,

[1] The translation of the passage from which the above is taken, though on the whole admirable, fails to do justice to the magniloquence of the original, which reads thus: "Toutes ces energies n'apparaissent à nous à de rares exceptions près que revêtues de cet uniforme qu'on appelle la matière. Une seule de ces energies se montre dépouillée de ce vêtement et nue. . . . Comment la définir autrement que la force en sa plus pure essence, puisque nous la contemplons comme un marbre antique *dans une superbe nudité* qui est aussi une beauté radieuse."

it is necessary to add, that this question must be answered in the negative. Whether or not we can imagine, or mentally represent, a thing as real, depends upon the question whether our past experience has furnished us the data for such a representation; and our experience is constantly furnishing us new data.

That the impossibility or difficulty of imagining a thing (which, however, must be carefully distinguished from the absolute impossibility of forming certain concepts, of which I shall presently speak) is no evidence for or against its reality, is a truth of the greatest moment to the student of natural science. Liebig expressed it long ago (*Ann. Pharm.*, x., 179), in the words: "The secret of all those who make discoveries is, that they regard nothing as impossible."

I come now to the conditions of conceivability, strictly and properly so called. These conditions are readily deduced from the incidents in the act of conception to which I have referred. These incidents are: The reduction of the elements of a representation to consistent unity by bringing them into relation, and the establishment of relations between the unit thus evolved and the previous concepts of the mind. A concept can, therefore, be formed, if *a*, its elements, can be united in thought by the establishment of relations between them by which they are reduced to a unit—in other words, if the constituent attributes are consistent with each other—and if *b*, the resulting concept, can be brought into relation, so as to be consistent with the previously-formed concepts of the mind.

Consistency of the constituent attributes with each other, therefore, is the *first*, and consistency of the concept with other concepts the *second*, condition of its successful formation. The first of these is what is known in logic as the law of non-contradiction, or the law of consistency, and is the fundamental condition of all thought. It requires that what is expressly or by implication asserted in the subject shall not expressly or by implication be denied in the predicate of any proposition into which the concept may be resolved, or, in plain words, that what is asserted in one form of words shall not be denied in another.

Now, it is evident that, whenever the formation of a concept involves a violation of the first condition, we have before us a case of absolute inconceivability, and therefore of impossibility. For this condition, as I have said, is the first constitutive law of all intelligence, without which the whole system of relations, in which both subjective and objective realities have their only warrant and support, instantly collapses into the nothingness in which alone all things are identical, and disappears in the night of absolute confusion. No one, not even John Stuart Mill, ever seriously doubted the absolute impossibility of the conception or existence of a round square, or of a straight line which is not the shortest distance between two points. Whenever such a doubt has been expressed, it has arisen from a mental con-

fusion as to the import of the terms employed in the propositions, as we shall see presently in the case of Mill.

But it is otherwise with the second condition of conceivability: that the concept, when framed, shall be consistent with other concepts previously formed. For these latter concepts may be spurious or invalid. Inconceivability arising from non-compliance with the second condition is therefore purely relative, depending on the validity of the concepts with which the concept in question appears to be incompatible. For example, until the discovery of the composition of water, of the true theory of combustion, and of the relative affinities of potassium and hydrogen for oxygen, it was impossible to conceive a substance which would ignite on contact with water, it being one of the recognized attributes of water—in other words, a part of the concept water—that it antagonized fire. This previous concept was spurious, and, when it had been destroyed, the inconceivability of a substance like potassium disappeared. Similarly, we are now unable to conceive a warm-blooded animal without a respiratory system, because we conceive the idiothermic condition of an animal organism to depend mainly on the chemical changes taking place within it, chief among which is the oxidation of the blood, which requires some form of contact between the blood and the air, and therefore some form of respiration. If, however, future researches should destroy this latter concept—if it should be shown that the heat of a living body may be produced in sufficient quantity by mechanical agencies, such as friction—a non-respiring warm-blooded animal would at once become conceivable.

Mill not only refuses to recognize the distinction between what may be conceived and what may be represented in imagination, but he also ignores the distinction between the cases of inconceivability from the one or the other of the two causes just mentioned; and he maintains that all conceivability whatever is relative. The examples which he discusses at length are all cases of inconceivability, and not of unimaginability, and I propose to notice the more important of them in passing. The most noteworthy of these examples is the inconceivability of a round square. In order not to do Mill injustice, it will be best to quote his own language ("Examination of the Philosophy of Sir W. Hamilton," vol. i., p. 88, *et seq.*, American edition):

"We cannot conceive a round square," says Mill, "not merely because no such object has ever presented itself in our experience, for that would not be enough. Neither, for any thing we know, are the two ideas in themselves incompatible. To conceive a round square, or to conceive a body all black and yet all white, would only be to conceive two different sensations as produced in us simultaneously by the same object—a conception familiar to our experience—and we should probably be as well able to conceive a round square as a hard square, or a heavy square, if it were not that in our uniform experience, at the instant when a thing begins to be round, it ceases to be square,

so that the beginning of the one impression is inseparably associated with the departure or cessation of the other. Thus our inability to form a conception always arises from our being compelled to form another contradictory to it."

Our inability to conceive a round square due to the fact "that in our uniform experience, at the instant when a thing begins to be round, it ceases to be square," and to the inseparable association between incipient roundness and departing squareness! Whether any one has ever had such experience as is here described, I do not know; but, if he has, I am confident that, even after being reënforced by a large inheritance of ancestral experience in the light of the modern theory of evolution, it will prove insufficient to account for the inseparable association which Mill brings into play. The simple truth is, that a round square is an absurdity, a contradiction in terms. A square is a figure bounded by four equal straight lines intersecting at right angles; a round figure is a figure bounded by a curve; and the oldest definition of a curve is that of "a line which is neither a straight line, nor made up of straight lines."

It ought to be said that there are expressions in the same chapter of Mill's book, from which I have just quoted, which show that the author was very ill at ease in the presence of his own theory. For instance, he says (ib., p. 88): "These things are literally inconceivable to us, our minds and our experience being what they are. Whether they would be inconceivable if our minds were the same, but our experience different, is open to discussion. A distinction may be made which, I think, will be found pertinent to the question. That the same thing should at once be and not be—that identically the same statement should be both true and false—is not only inconceivable to us, *but we cannot conceive that it could be made conceivable.*"

That so clear and vigorous a thinker as Mill should have been capable (especially when he was grappling with the thoughts of a man like Sir W. Hamilton) of writing these sentences, is indeed wonderful. First, he denies that inconceivability is, in any sense or in any case, a test of truth or reality; but then he says it may be otherwise, if the inconceivability itself is inconceivable! That is to say: a witness is utterly untrustworthy; but, when he makes a declaration respecting his own trustworthiness, he ought to be believed!

That the whole theory of inseparable association, as here advanced and applied by Mill, is without foundation, it being impossible, under his theory, to know what the experience of his numerous readers has been, except again by experience which he cannot have had, since most of these readers were utterly unknown to him—that all attempts to argue questions with any one on such a basis are supremely foolish, Mill being bound, by his own doctrine, to accept the answer, "My experience has been otherwise," as conclusive—that this theory is suicidal and subversive of itself, and that every earnest sentence Mill

has ever written is its practical refutation—is too obvious, almost, to require pointing out.

While the example just discussed was a case of absolute inconceivability, the other instances given by Mill are cases of true relative inconceivability. The first is that of antipodes which were long held to be impossible, and are now not only readily conceived as possible, but known to be real. This is true enough, but it finds its explanation, not in the law of inseparable association to which it is referred by Mill, but in the fact that our ancestors held an erroneous concept of the action of gravity. They supposed that the direction in which gravity acted was an absolute direction in space; they did not realize that it was a direction toward the earth's centre of gravity; *downward* to them meant something very different from the sense we attach to that word. With this erroneous concept they could not reconcile the fact that the force of gravity held our antipodes in position as well as ourselves; nor can we. But we have a juster concept of gravity, and the mode and direction of its action; the spurious notion with which the notion of antipodes was inconsistent, has been removed, and the inconceivability of antipodes is at an end.

Similar observations apply to Mill's remaining example (which is to us the most interesting, and that for the sake of which I have carried the discussion of this dry subject to this length) of the inconceivability of *actio in distans*, to which I have already alluded. The true source of our inability to conceive *actio in distans* is, I trust, now apparent. This inability results from the inconsistency of this concept with the prevailing concepts respecting material presence. If we reverse the proposition, that a body acts where it is, and say that a body is where it acts, the inconceivability disappears at once. One of the wisest utterances ever made on this subject is the saying of Thomas Carlyle (quoted by Mill himself in his "System of Logic," in another connection): "You say a body cannot act where it is not? With all my heart; but, pray, where is it?" Of course, a reconstitution of our concepts of material presence, in the sense here indicated, would be in utter conflict with the theory of the mechanical construction of matter from elements which are absolutely limited, hard, unchangeable, and separated from each other by absolutely void spaces. It is significant that nearly all the efficient laborers in the quarries of physical science vaguely feel, if they do not distinctly see, that such a reconstitution is necessary. Such a feeling was at the bottom of Faraday's attempt to construct matter out of the convergence and intersection of mere lines of force, so as to secure to each point of intersection (or, in the language of Faraday, to each centre of force) a virtual omnipresence, the extent of the lines of force being infinite.

I may be permitted to say, at the end of this long but unavoidable excursion into the regions of logic and psychology, that the doctrine, according to which there is no warrant for the deliverances of our

consciousness except the cumulation of purely sensational experience, which not only *may* but *must* vary with the position of the intellects interpreting it—that truth, therefore, is nothing but the inveteracy of error—is the dreariest creed ever promulgated; and its association with the many noble truths of which John Stuart Mill has been the discoverer or the champion, is the most unfortunate "inseparable association" established in recent times. And it is deplorable that Herbert Spencer, who has the merit of being one of the most energetic fumigators of the intellectual atmosphere of our time, should evince a disposition to make concessions to such a creed, and endeavor to eke out its shortcomings by the doctrine (in itself, no doubt, both sound and fertile) of the inheritance of ancestral tendencies of the mind. His own theory leads to conclusions utterly subversive of Mill's doctrine; for, if organic life (including the life of the mind) has been continuously evolved from inorganic matter, then the lines of our ancestry run into all the phenomena of the material world, and the order of these phenomena must be ingrained, not only in the structure of our bodies, but also in the constitution of our minds. Or, to express it in the language of modern comparative psychology: the ancestral inheritance of our intellects must embrace, not only the associations established by experience between the phenomena of consciousness in the minds of our progenitors, but also the regularity in the evolution of the natural events which gave rise to these phenomena—the laws of Nature. These laws must, therefore, in a certain sense, be prefigurations of the forms of our intellect, so that, after all, there is truth in the sentence of Protagoras, that man is the measure of all things, and sense in the words of Goethe (almost identical with a passage in Plotinus), that the eye sees the light, because it is of solar nature. I do not, of course, mean to stand committed to this argument in the form in which it is here presented, not entertaining the notions respecting the relations between organic and inorganic forms which underlie it, and doubting that the continuity of the evolution of these forms is truly represented by current beliefs. But, with the proper modification of its premisses (which, however, cannot be affected by a few verbal definitions), I believe the argument in favor of the *a priori* sanity of the human intellect to be valid, in spite of certain structural fallacies resulting from the laws of its growth, which I shall have occasion to discuss in my next article; and I further believe the primordial correspondence between the intellect and its objects to be entirely consistent with the theory of evolution, Max Muller to the contrary notwithstanding.

SKETCH OF MR. J. N. LOCKYER, F. R. S.

THE subject of this notice, Mr. JOSEPH NORMAN LOCKYER, is a young astronomer who has cultivated his science assiduously, and made his mark as an investigator in the field of solar physics. He was born on the 17th of May, 1836, at Rugby, in Warwickshire, England. He inherited from his father a predilection for scientific studies; for, if the elder Lockyer had not the honor of being the first, he was one of the first who contrived methods of telegraphing by electricity.

At a very early age, young Lockyer was deprived of his parents, and, after attending one or two private schools in England, where he picked up the first rudiments of his education, the orphan boy went abroad, and there continued his studies for several years. Upon his return to England, he obtained a position under government, in the War-office, the duties of which have occupied him regularly for the past sixteen years; his astronomical and literary work having been performed in the intervals of time snatched from the government service. In 1858, he married an accomplished and intelligent lady, who not only sympathized with him in his scientific pursuits, but has also shared his work and rendered the most valuable assistance in various of his undertakings.

In 1862, he contributed a very important paper to the memoirs of the Royal Astronomical Society, on the planet Mars, giving the results of his telescopic observations on the physical conditions and configuration of its surface. In 1865, in conjunction with Thomas Hughes, the popular author of "Tom Brown at Rugby," he was appointed editor of the army regulations, and placed upon an improved basis the system of War-office legislation. In 1865, in recognition of his services as an astronomical observer, he was elected a Fellow of the Royal Astronomical Society.

Solar observations had for some time attracted much of Mr. Lockyer's attention, and in that year he propounded his method for observing the grand solar phenomena of the red flames with the spectroscope at any time when the sun is visible, whereas previously it had been impossible to see them except under the obscuration of a total or annular eclipse. A more powerful spectroscope than any then available was needed to solve this problem, and, at Mr. Lockyer's solicitation, the Royal Society made a grant for this purpose. Vexatious delays occurred in the construction of the instrument, and he did not get it until two years later. The idea, however, proved successful, and Mr. Lockyer made the brilliant discovery in which he had been so long baffled for lack of means. He sent the account of it to the French Academy, and his note had been hardly read, when news came

that the French astronomer Janssen, then in India, had made the same observation two months before. The independence of these discoveries was recognized, and the French Academy struck a joint medal in honor of them.

Mr. Lockyer has prosecuted his spectroscopic researches on the sun with great industry and fruitful results, and, in conjunction with Prof. Frankland of the Royal School of Chemistry, has made a series of interesting experiments on the relation of gases under pressure to the spectrum lines, thus throwing important light on the changes taking place in the solar atmosphere.

Mr. Lockyer's contributions to scientific literature, as an author of books, a periodical writer, and a scientific editor, have been numerous. In 1862, he had editorial charge of the scientific department of *The Reader*, and subsequently edited the English edition of "The Heavens," by Guillemin. In 1868, he published his excellent school treatise on "Elementary Astronomy," and in 1869 became the editor of *Nature*, when that able scientific paper was established by Macmillan & Co. Last year "The Forces of Nature," an elaborate work, by the author of "The Heavens," appeared, with amendments and additions from his pen. He has published, during the present year, an excellent little volume on "Spectrum Analysis," being a course of lectures delivered in 1869, and revised to date. It is beautifully illustrated, and forms the first of Macmillan's "Nature Series."

In 1870, he was appointed by the English Government chief of the expedition sent out to Sicily for the purpose of observing the solar eclipse, and, in addition to his other work, accepted the secretaryship of the Royal Commission on Scientific Institutions and the Advancement of Science. In 1871, having been named assistant commissioner, he was requested to draw up a report on science-teaching in English and Continental schools, and the same year he received the honorable appointment of Rede Lecturer at Cambridge.

Mr. Lockyer is a gentleman of courteous and affable manners, a vivacious conversationist, and a ready and fluent public speaker. Like many other scientific Englishmen, he recognizes that he owes a duty to this country, and hopes to be able to discharge it when he can get release from his multifarious engagements. He has been invited by the Lowell Institute to give a course of astronomical lectures in Boston, and, when he comes to deliver them, he will probably repeat the series in some of the other cities of the country.

EDITOR'S TABLE.

THE RELATIONS OF BODY AND MIND.

THE question of the relation of the mental and the corporeal powers has always had a deep speculative interest; but, as science is gradually working it out, it is found to have also a profound practical interest. It is strange that a subject of such fascination, and concerning which so much has been said in all ages, should be so late in its rational elucidation. But, besides the difficulties which spring from its extreme complexity, the inquiry has been perpetually hindered by prejudice and passion. Singular as it may appear, the acquisition of the most important of all knowledge, that of the human constitution by dissection, has been held as a crime until the present generation. The prejudice that led to this result led also to the further result that the most important part of the human system, that which is specially devoted to psychical ends, has been considered last. The early anatomists refrained from dissecting the head for fear of committing impiety, and there remained, long after, a kindred feeling against the analysis and study of the brain. Even when it had been demonstrated, and was admitted by all physiologists, that the brain was the organ of the mind, there still lingered with many a belief that it was a sort of unaccountable, half-superfluous appendage to the body, with no such reason for its existence as was obvious in the case of other anatomical parts. Physiologists might show that it had special relations with the mind, but the students of mental philosophy denied that it was of any importance to them, and proceeded with their inquiries as if it had no existence at all. Buffon described the brain as consisting of a kind of "ignorant mucilage," and the Rev. F. W. Robertson expressed the general metaphysical and theological contempt for it by ridiculing the idea of accounting for mental effects "by a few ounces more or less of the hasty-pudding contained within the skull." We are indebted to the phrenological school for having made a vigorous fight in behalf of the claims of the head upon the students of mind, and, whatever may be the imperfections of their scheme, they have certainly cleared away a vast amount of prejudice in the popular mind, and prepared for the consideration of the material apparatus in connection with mental phenomena.

It is now well established that, in the study of mind and character, the physiological organism is not only to be taken into account, but is to be made the basis of investigation. Metaphysical treatises open with a description of the nervous system, even if it plays no part in the subsequent exposition. But, wherever mind is studied with a view to practical ends, it is found necessary not only to admit in a general way the intimate dependence and close interaction of the mental and corporeal systems, but the relations have to be worked out with the utmost detail on both sides. In dealing with abnormal mental manifestations, as in the numerous forms of insanity and the various grades of feeble-mindedness, or with the psychological effects of stimulants and narcotics, or with the development and decline of the mental powers, or with the effects of mental overwork and exhaustion, it is now admitted to be indispensable to start from the nervous system, and to regard mental manifestations as conditioned by its properties and laws. Thus far it is only physicians, compelled

by the exigencies of practice, and prepared with the requisite physiological knowledge, who thoroughly accept this point of view, but it is the point of view that must yet be taken by all who deal with the phenomena of human nature on the basis of real and applicable knowledge. Especially in that profession which aims to direct the development of the mind and character of the young, must the corporeal side of their nature be thoroughly and systematically studied. We lately heard of a professor, high in honor and reputation as a teacher of teachers, whose text-books of mind are the metaphysical treatises of Stewart and Hamilton, and who strenuously denies that corporeal considerations have any right to be imported into the question: happily, the class to which he belongs is fast passing away. He who aspires to the noble work of developing a human being must take the whole nature of that being into account. He has no right to cleave it asunder and throw away one part of it, especially that part which is the organism of life, and brings the individual into relation with the universe. The teacher who has only attained an intellectual comprehension of certain branches in which he is to give instruction, has hardly entered upon his preparation. As we have elsewhere written: "Education is an affair of the laws of our being, involving a wide range of considerations—an affair of the air respired, its moisture, temperature, density, purity, and electrical state in their physiological effects; an affair of food, digestion, and nutrition; of the quantity, quality, and speed of the blood sent to the brain; of clothing and exercise, fatigue and repose; health and disease, or variable volition and automatic nerve-action; of fluctuating feeling, redundancy and exhaustion of nerve-power, sensuous impressibility, temperament, family history, constitutional predisposition, and unconscious influence; of material surroundings, and a host of agencies which stamp themselves upon the plastic organism and reappear in character."

The latest contribution to the literature of this subject is a little book entitled "Mind and Body: the Theories of their Relation,"[1] by Prof. Alexander Bain, author of "The Senses and the Intellect," and "The Emotions and the Will." The volume that now appears represents the leading facts of the question, and their latest theoretical interpretations, and closes with an interesting review of the course of past speculation upon the subject.

It being now established that the brain is the material instrument of the mind, the questions are inevitable, What do we actually know, and how much is it possible to know, of the conditions of this union? It is not enough to recognize that when the circulation of the blood in the brain is arrested, as in fainting, consciousness ceases, nor that alcohol in its influence upon the nervous system modifies mental action in one way, and opium and hashish in other ways; that which we require to understand is, in what manner the mechanism and action of the brain are specially related to the mechanism and action of the mind. Nor is the question as to the ultimate nature of mind and matter, or *how* they can exist together, for this is beyond the province of science to determine. What are the essence of mind and the essence of matter, and whether they are at bottom two things or one thing, are beyond ascertainment, and will prob-

[1] This is number IV. of "The International Scientific Series." In arranging the works of this series, which aims to represent the latest result of thought, it was deemed important that the new psychology should be fully treated, and by the most competent men. Prof. Bain was accordingly engaged to deal with the more general and philosophical aspects of the subject, while the volume of Dr. William B. Carpenter, in the same series, will be a regular practical text-book of mental philosophy from the physiological point of view. It will be issued in January, under the title of "The Principles of Mental Physiology: with their Applications to the Training and Discipline of the Mind, and the Study of its Morbid Conditions."

ably ever remain so. The nature of the union is a mystery, just as the nature of the union between gravity and matter is a mystery; in both cases we investigate only the laws of the phenomena. As the problem is one of the connection between two systems of action, the first step toward its solution must be to resolve these two systems into their simplest elements. The structural elements of the nervous system are marvelously simple; they consist of microscopic cells and fibres, the former being seats or centres of force, and the latter being the means of transmitting it.

Cells and fibres are the instruments of mental action, and, exactly as we rise in the scale of intelligence in animated creatures, there is an increase in the mass of the nervous centres—that is, a multiplication of the nerves and fibres which constitute them. In man, the most intelligent of the animal series, the organ of intelligence is relatively very large, and attains the highest degree of complexity.

Prof. Bain represents the nervous elements of the human brain as follows: "The thin cake of gray substance surrounding the hemispheres of the brain, and extended into many doublings by the furrowed or convoluted structure, is somewhat difficult to measure. It has been estimated at upward of 300 square inches, or as nearly equal to a square surface of 18 inches in the side. Its thickness is variable, but, on an average, it may be stated at one-tenth of an inch. It is the largest accumulation of gray matter in the body. It is made up of several layers of gray substance divided by layers of white substance. The gray substance is a nearly compact mass of corpuscles of variable size. The large caudate nerve-cells are mingled with very small corpuscles less than the thousandth of an inch in diameter. Allowing for intervals, we may suppose that a linear row of 500 cells occupies an inch, thus giving 250,000 to the square inch for 300 inches. If one-half of the thickness of the layer is made up of fibres, the corpuscles or cells, taken by themselves, would be a mass one-twentieth of an inch thick, say 16 cells in the depth. Multiplying these numbers together, we should reach a total of 1,200,000,000 cells in the gray covering of the hemispheres. As every cell is united with at least two fibres, often many more, we may multiply this number by four for the number of connecting fibres attached to the mass, which gives 4,800,000,000 fibres."

Now, in saying that such a wonderful organism as this is the seat and embodiment of the mind, we require to give distinctness to our conceptions, and are compelled to regard the connected cells and fibres as the simple instruments of simple mental processes as the whole fabric is the organ and measure of the whole mind. The corporeal elements are cells and fibres—what are the psychical elements in their lowest analysis? The old division of of the mind into faculties—as reason, judgment, memory, and imagination—is insufficient, for these are far from being ultimate elementary processes, but are rather the most complex actions of the collective forces of the intelligence in different modes of exercise. The later psychology resolves all these so-called faculties into a few constituents which form, if we may so speak, the contexture of the intellect. As Prof. Bain remarks: "We have no power of memory in radical separation from the power of reason or the power of imagination. The classification is tainted with the fault called in logic 'cross-division.' The really fundamental separation of the powers of the intellect is into three facts, called: 1. Discrimination, the sense, feeling, or consciousness, of difference; 2. Similarity, the sense, feeling, or consciousness, of agreement; and, 3. Retentiveness, or the power of memory or ac-

quisition. These three functions, however much they are mingled in our mental operations, are yet totally distinct properties, and each the groundwork of a different superstructure. As an ultimate analysis of the mental powers, their number cannot be increased or diminished; fewer would not explain the facts, more are unnecessary. They are the intellect, the whole intellect, and nothing but the intellect."

This resolution of the intellect into ultimate discriminations of likenesses and differences among things recognized, remembered, and thought about, and, as a consequence, the growth or development of the intellect as a successive combination and recompounding of these relations of discrimination, is an immense step forward in the progress of scientific psychology, because it first brings into close correspondence the two orders of activity. Instead of merely wondering at the brain as an inexplicable mass of mucilage, we now regard it as an organism built up with exquisite delicacy out of thousands of millions of cells and fibres, with myriads of intimate connections, all guarded most securely and put into multiplied and marvelous relations with the external universe. It is impossible here to go into the details of the subject, and we have aimed only to state the present attitude and tendency of psychological inquiry, which is briefly this: Our feelings and volitions, aptitudes and acquisitions, are elements of mind having their corporeal side which it is both indispensable and possible to understand—great progress having been recently made in the investigation. Much in the relations of the cerebral structures to mental action is still profoundly obscure, but much is also already known which is of the highest service for useful guidance. Metaphysics has been hitherto proverbially barren, because it has insisted upon considering mind as an isolated abstraction; while modern psychology, by regarding the whole nature as a unity, promises, on the other hand, to be eminently productive of practical results.

MEETING OF THE BRITISH ASSOCIATION.

THE British Association for the Advancement of Science commenced its forty-third session September 17th, in the town of Bradford. Dr. Carpenter resigned the presidency, and, as the health of Dr. J. P. Joule, his successor-elect, did not allow him to assume the duties of the chair, it was taken by Prof. Williamson, the eminent English chemist, who devoted his inaugural address to the discussion of his own department of science. After a handsome tribute to the memory of Liebig, Prof. Williamson entered into an exposition of the present conditions of chemical science, the directions of its greatest activity, the present state of chemical theory, and the general relations of scientific education to the advancement of knowledge. The whole paper is able, but it did not arrive in time for publication in the present number of the MONTHLY.

The chairman of the biological section was Prof. Allman, the distinguished zoologist of the Edinburgh University, and his address, upon taking the chair, seems to us a very able and instructive scientific discussion. But what is the British Association for the Advancement of Science about, in putting at the head of its biological branch a man who favors Darwinian notions, and is consequently a sham scientist? Do they not know that from the Yankee Vatican has gone forth a bull which excommunicates them and their seed to the end of time? In his lively address before the Free Religious Association, in Boston, last May, Colonel Higginson apologized for the extent of theological disagreement by

pointing out the diversities of scientific opinion, and remarked: "I heard one of the greatest scientific men in America reply, when somebody said, 'You must at least admit that there is a division of opinion among scientific men in regard to the doctrines of Darwin,' 'No, there is no difference of opinion among scientific men.' 'Why not?' 'Because,' said he, 'no man who supports the doctrines of Darwin is entitled to be called a scientific man.'" As to who the great man was who made this destructive remark, nobody will need to guess twice; but it squelches Prof. Allman, and turns the British Association out-of-doors as a lot of mere scientific pretenders, for their representative biologist aired his vagaries as follows: "I have thus dwelt at some length on the doctrine of evolution, because it has given a new direction to biological study, and must powerfully influence all future researches."

Prof. Allman regards the doctrine of evolution as a great and actual truth of Nature, still obscured and embarrassed by many difficulties, and in this he is at one with its oldest and strongest adherents; but he insists that it harmonizes and explains so extensive a range of facts, which are without explanation on any other view, as to become invaluable as an instrument of scientific research. On this point he says:

"The hypothesis of evolution may not, it is true, be yet established on so sure a basis as to command instantaneous acceptance, and for a generalization of such wide significance no one can be blamed for demanding for it a broad and indisputable foundation of facts. Whether, however, we do or do not accept it as firmly established, it is, at all events, certain that it embraces a greater number of phenomena, and suggests a more satisfactory explanation of them, than any other hypothesis which has yet been proposed. . . . Or, finally, is the doctrine of evolution only a working hypothesis which, like an algebraic fiction, may yet be of inestimable value as an instrument of research? For, as the higher calculus becomes to the physical inquirer a power by which he unfolds the laws of the inorganic world, so may the hypothesis of evolution, though only an hypothesis, furnish the biologist with a key to the order and hidden forces of the world of life. And what Leibnitz and Newton and Hamilton have been to the physicist, is it not that which Darwin has been to the biologist?" Only to think of it! Would it not have been well if those British scientists had got some American to teach them what science is, and how to preserve it from perversion and degradation?

PROFESSOR CZERMAK.

Our readers will recall an important lecture on "Hypnotism in Animals," a translation of which, by Miss Hammond, appeared in The Popular Science Monthly for September. It gave some of the results of a very interesting research in comparative psychology; and, in a second lecture upon the same subject, in the present number, the results of the investigation are continued, with some strictures on the so-called experimental investigations of "spiritualism." The originality of this inquiry, and the practical lesson that is drawn from it, will be sufficient to secure a careful perusal of these discourses, but the reader's interest in them will be increased by the painful announcement of the recent death of their distinguished author, which occurred September 15th. Prof. Czermak was the head, and in fact the proprietor, of the famous Physiological Laboratory in Leipsic, where he lived. He was the inventor of the laryngoscope, and his treatise upon it was translated and published by the Eng-

lish Sydenham Society. He was a man of large wealth, which he liberally devoted to the work of science by maintaining his physiological school; and, besides being a skillful and able investigator, he was a man of enlarged culture and earnestly sympathetic with all measures and movements for the diffusion of valuable knowledge among the people. He was warmly interested in carrying out the project of the "International Scientific Series," being a member of the German committee to decide upon the contributions from that country; and, had he lived, he would have prepared a volume for the series himself. He wrote and spoke the English language with ease and elegance, and his wife conversed in it so fluently and perfectly that the writer felt sure she must be an American lady, if not English, until he learned that she had never been out of Germany. Prof. Czermak died of a lingering disease from which he had long suffered.

MR. PROCTOR'S LECTURES.

MR. RICHARD A. PROCTOR, the eminent English astronomer, is to lecture in this country during the ensuing season. We need hardly say that he is a first-class man, and stands among the ablest in his chosen department of science. Nor is he a mere recipient and reporter of other men's ideas; he has views of his own, and has made his independent contributions to the extension of astronomical science. But it is as a lucid and attractive writer on astronomical themes that Mr. Proctor is chiefly known. He has written an elaborate work on "The Sun," and has just published a corresponding volume on "The Moon;" these, with "Other Worlds than Ours," and his numerous and excellent papers in the reviews on stellar astronomy, show his thorough familiarity with the whole field of celestial phenomena. Mr. Proctor is said to be a clear, rapid, and forcible speaker, which, with his illustrations, will make his lectures the leading scientific entertainment of the season.

LITERARY NOTICES.

THE PHILOSOPHY OF EVOLUTION. (An Actonian Prize Essay.) By B. THOMPSON LOWNE, M. R. C. S., F. L. S. London, John Van Voorst.

HANNAH ACTON, relict of Samuel, had opinions. In this there was certainly nothing remarkable, but she had also that which gives dignity and power to opinion, that is, money to back it. Ideas amount to very little until incarnated, and then they acquire an immense and lasting influence. A narrow-minded blockhead may cherish views that nobody regards as worth listening to, but if he puts a few hundred thousand dollars behind them, and founds a college for carrying them out, they suddenly rise into respectability, and are made potential for generations. Our friend Hannah had a notion that there prevails a very low estimate of the wisdom and goodness of the Creator of the universe, and she was willing to spend money to raise the standard, so she placed a thousand pounds of good solid investments in the hands of a committee of the Royal Institution of Great Britain, to appropriate the interest, every seven years, in the shape of a prize of one hundred guineas, for the best essay, "illustrative of the wisdom and beneficence of the Almighty, in such department of science as the committee should select," leaving it to their discretion to withhold the reward if none of the essays produced were thought worthy of it. Seven years ago, the solar radiations—certainly a magnificent subject—was proposed for a prize; but, as nothing appeared upon that theme which would to any extent promote the donor's intention, the money was not granted. So the funds accumulated, and this year two prizes were offered, one of them for the best essay on the "Law of Evolution, as illustrating the Wisdom and Beneficence of the Almighty," and B. Thompson Lowne got the golden prize for writing the little book before us. The fact is notable as showing the advance of thought, for no transformation suggested by the evolutionists as taking place among the lower animals

is more surprising than that transformation of opinion in the scientific world that has made such an award as this possible; and, if Aunt Hannah had been as prophetic as she was devout, and scented afar the use that would be made of her money, it is questionable if the Royal Institution would ever have got a shilling of it. As for the book itself, it is but a sorry performance. It has been sagely remarked, concerning prize sheep and prize essays, that the former are useful only for making candles, and the latter for lighting them; and the observation is as true of Mr. Lowne's book as of the class to which it belongs, for it is certainly the poorest piece of work upon the subject that we have yet seen. Most contributions to this question are inspired by such an interest in it as to enforce study and secure some merit; but this contribution has obviously been made for a hundred guineas. Literary labor need not be necessarily bad because it is paid for, but prize essays are an open appeal to mercenary motives, and are apt to attract those who are mainly influenced by them. Mr. Lowne undoubtedly knows something of his subject, but he neither contributes any thing to its original thought, nor, what was equally needed, has he given us a clear and full popular representation of it. The book which shall perform that office remains yet to be written.

ELEMENTS OF PHYSICAL MANIPULATION. By EDWARD C. PICKERING, Thayer Professor of Physics in the Massachusetts Institute of Technology. 8vo. 225 pages, price, $3.00. New York: Hurd & Houghton.

THERE are hopeful signs that the despotic rule of the verbal system in education has had its day, and must lose its supremacy in future exactly in the ratio of the advance of thorough scientific education. Nothing can be more futile than the mere verbal teaching of physical laws, when it is possible, by the performance of simple experiments, to bring their operation directly before the student's mind. It is quite as preposterous as the prevailing habit of learning the descriptive and observational sciences by memorizing the statements of books rather than by the direct study of the objects themselves. That nine-tenths of the school-study of science is at present an unmitigated educational sham but few will deny, and what is now wanted is less an increase in the amount of scientific study than a radical amendment of its method. This want is widely felt, and is beginning to be efficiently supplied. Botanical and zoological text-books are becoming more and more guides to Nature, and there is springing up a separate literature of working processes in the experimental sciences. Treatises on manipulation have long been standard necessities in chemical laboratories, and they are now recognized as of equal importance in laboratories devoted to other departments of experimental science. The admirable volume of Drs. Burden-Sanderson and Michael Foster, on "The Processes and Manipulations of the Physiological Laboratory," is a recent English contribution in this direction; and the "Introduction to Physical Measurements," by Dr. F. Kohlrausch, of Darmstadt, the translation of which has just been issued by Churchill, of London, is a valuable volume of the same kind. Prof. Pickering's new book, however, is now by far the best guide that we have for the practical teaching of natural philosophy. Assuming that the instruments are in the hands of the student, it shows him precisely how to use them, what precautions to take, and what errors to avoid. "It is intended as a hand-book for teachers, for the large class of amateurs who devote their leisure to some branch of physical inquiry, and more particularly as a text-book for the physical laboratories now introduced so generally in all our larger colleges and scientific schools.

"It is hoped that it may also aid the introduction of the laboratory system into the high-schools and academies, as many of the experiments are simple enough to be performed there, and, at the same time, the kind of apparatus described is such that it can be made at very small expense."

The preliminary chapter is devoted to general methods of investigation and the more common applications of the mathematics to the discussion of results, and a short description is also given of the various methods of measuring distances, time, and weights, which, in fact, form the basis of all physical investigation. The remain-

der of the volume is occupied with a series of experiments upon the following general topics: the mechanics of solids, the mechanics of liquids and gases, and the phenomena of sound and light. The work is written in a clear style, is neatly and fully illustrated, and is the result of four years' practical experience in the physical laboratory of the Massachusetts Institute of Technology. It is gracefully dedicated to Prof. William B. Rogers, the founder of that institution, "as the first to propose a physical laboratory." The rapid spread of the laboratory system of teaching physics in the higher schools of this country will open a wide field of usefulness for Prof. Pickering's excellent text-book.

CIVILIZATION CONSIDERED AS A SCIENCE. By GEORGE HARRIS, F. S. A. 382 pages. Price, $1.50. D. Appleton & Co.

ALTHOUGH the author of this volume is a lawyer, and is disposed to consider his subject very much in the light of his professional studies, that is, from the standpoint of the moral sciences, yet he accepts the broader view which regards civilization as part of the order of Nature, and as, therefore, dependent upon many sciences for its interpretation. His aim, however, is not purely scientific, that is, to analyze and generalize the phenomena of civilization; but, recognizing the government of natural law, he rather attempts a practical discussion of those agencies of civil and social advancement which are most perfectly under public control. He writes with a view to the improvement of society, rather than to the understanding or explanation of it, and his book would have been more completely described by the title "Civilization considered as a Science and an Art." Mr. Harris first inquires into the essential constitution of civilization, to determine what are its factors or the various forces and instrumentalities that have coöperated in its development. Individual enterprise, scientific discoveries and inventions, education, legislation, internal and external intercourse, religious institutions, language and literature, and racial, climatic, and geographical conditions, are all enumerated as elements of the grand result, while the various values of these several elements are considered in the successive chapters of the book. The present work is a new and revised edition of a volume that appeared several years ago. The result of his progressive studies has been, materially to modify the author's opinions on points at first held to be all-important. He at first considered that legislative measures, expressly adapted for the purpose, are the main means by which civilization has been promoted; but a careful examination of the subject soon sufficed to correct this error. The subtler and more pervasive influence of education was next fixed upon as "constituting the real efficient cause, if not the actual essence of civilization." But further inquiry convinced the author that here also he was so profoundly wrong that he regards the refutation of this fallacy as the main purpose of his work. He says: "Upon taking a comprehensive view of the whole matter, in all its different bearings, and with regard to all its varied requirements, the ultimate conclusion which I arrived at was, that which is not only really needed, but what is, in fact, in many cases, actually intended in the demands for the intellectual and moral improvement and advancement of the nation, is not education merely, but civilization generally. This principle, which has not been adopted without the fullest deliberation and the sincerest conviction of its truth, is the basis of the doctrine propounded in the following pages, and its recognition is deemed of the utmost consequence to the well-being of society. Education is, in fact, so to speak, one only out of several of the chains by which the car of civilization is drawn onward. By applying to this one alone, not only is the machine moved very feebly and very slowly, but there is considerable danger incurred of snapping the single chain."

Mr. Harris puts forth no claim to the discovery or extension of the scientific theory of civilization, but his book contains much information and many important suggestions upon the subject.

THE LOGIC OF ACCOUNTS; a New Exposition of the Theory and Practice of Double-Entry Book-keeping. By E. G. FOLSOM, A. M. Price $2.00. A. S. Barnes & Co.

THERE are two kinds of school-books upon the same subjects. One is written from the art point of view, and the other

from that of science; one deals with rules and rote, and the other with principles; one narrows, the other widens; one makes of a student a good machine, the other an educated thinker. Mr. Folsom's book-keeping is to be commended on broad educational grounds, as it presents the subject in its logical and scientific form, suitable for liberal mental training. The difficulty with book-keeping, as with arithmetic, is that, under pressure of the utilitarian spirit, they are degraded into mere blind mechanical operations, acquired as a kind of dexterity, and solely with a view to business. Book-keeping is commonly learned in much the same way as the management of the sewing-machine, and to little better purpose, so far as mental cultivation is concerned. Mr. Folsom aims to redeem the study to its higher uses by treating it as a science of values and exchanges, which depends upon reasons and laws. While making due provision for the practice of the art, his constant method is to keep in view the principles which should guide the student's thinking. A work like this, pursued thoughtfully and thoroughly, in its philosophic spirit, will afford the most valuable preparation for studying the science of political economy, which treats of the laws of value and exchange as affecting communities and nations on the largest scale.

ANTIQUITIES OF THE SOUTHERN INDIANS, PARTICULARLY OF THE GEORGIA TRIBES. By CHARLES C. JONES, Jr. Large octavo, 532 pages, illustrated with Thirty-one Plates, and several Woodcuts. Price $6.00. New York: D. Appleton & Co., 1873.

WE have before briefly noticed this valuable contribution to American archæology, and now proceed to give our readers a further account of it, as, since the publication of the "Ancient Monuments of the Mississippi Valley," no work has been written upon this subject so minute in its details, so careful in statement, and so extended in its observations. Although the antiquities of Georgia claim the author's particular attention, he presents an intelligent and comprehensive view of the ancient monuments and aboriginal relics of that portion of the territory of the United States which is bounded on the north by Kentucky and the upper limits of Virginia, on the east by the Atlantic Ocean, on the south by the Gulf of Mexico, and on the west by the Mississippi River. The field of research—which is manifestly one of great interest, abounding with relics of unusual variety, symmetry, and beauty—has hitherto been but feebly explored. Here, in ancient times, dwelt peoples who apparently occupied a middle position in the scale of semi-civilization; influenced, on the one hand, to a greater or less degree, by those ideas which in Mexico and Central America culminated in such complex and elaborate developments, and, on the other, sympathizing with and sharing in those ruder expressions characteristic of Western hunter tribes and their more northern neighbors.

"Our object has been," says the author in his preface, "from the earliest and most authentic sources of information at command, to convey a correct impression of the location, characteristics, form of government, social relations, manufactures, domestic economy, diversions, and customs of the Southern Indians, at the time of primal contact between them and the Europeans. This introductory part of the work is followed by an examination of tumuli, earthworks, and various relics, obtained from burial-mounds, gathered amid refuse-piles, found in ancient graves, and picked up in cultivated fields and on the sites of old villages and fishing-resorts. Whenever these could be interpreted in the light of early-recorded observations, or were capable of explanation by customs not obsolete at the dawn of the historic period, the authorities relied upon have been carefully noted."

In the first four chapters we are made acquainted with the political, social, and industrial status of the Southern Indians, as disclosed by the narratives of the Spanish expeditions, and portrayed in the accounts of the early voyagers. The five succeeding chapters are devoted to a history of mound-building, and to a description of various groups of mounds with their attendant inclosures and fish-preserves. Among these ancient tumuli, antedating the period of European colonization, are mentioned and classified temple-mounds, terraced mounds, truncated pyramids, mounds of observation and retreat, chieftain-mounds, family or

tribal mounds, shell mounds, stone tumuli, and single graves. In this region there is a remarkable absence of megalithic monuments and animal-shaped mounds. The presence of rock-walls, embankments, and defensive inclosures, is noted; and, in connection with the grave-mounds, cremation and sundry funeral customs are alluded to and discussed. The plans of these prominent indications of early constructive skill are based upon original surveys, and the impressions conveyed of the monuments themselves are derived from the personal observations of the writer. The author does not concur in the opinion, so often expressed, that "the mound-builders were a race distinct from, and superior in art, government, and religion to, the Southern Indians of the fifteenth and sixteenth centuries." His reasons are fairly and cogently stated, and it is shown that the practice of sepulchral mound-building, and the construction of elevated spaces for chieftain-lodges and council-houses, were perpetuated within the historic period. In accounting for the marked decadence in industry, combined labor, craft and power which characterized these peoples in the eighteenth century, when their condition is contrasted with that of their ancestors, two centuries before, it is suggested that "the inroads of the Spaniards violently shocked this primitive population, imparting new ideas, interrupting established customs, overturning acknowledged government, impoverishing whole districts, engendering a sense of insecurity until that time unknown, causing marked changes, and entailing losses and demoralizations perhaps far more potent than we are inclined, at first thought, to believe."

Extended reference is made to the location and contents of refuse-piles and shell-heaps—objects which have of late attracted so much attention in many parts of the world, indicating, as they do, the resorts of primitive peoples, furnishing evidence of the food upon which they subsisted, and revealing the implements and utensils upon which they relied for daily use.

Stone-graves and the use of copper are treated of in the tenth chapter. Plate VI.—in which are figured the relics found in a stone-grave in Nacoochee Valley—possesses unusual beauty, and conveys an emphatic idea of the commercial relations existing among the North American tribes. From this grave were taken a laminated copper axe, which had probably been obtained from the shores of Lake Superior, a *cassio flammea*, from the Gulf of Mexico or the Atlantic coast, the remnant of a basket made of a reed not native to the valley, and stone implements laboriously constructed of materials brought from a distance. All these were once the property of a single individual.

In the chapters upon arrow and spear heads—grooved, wedge-shaped, perforated, and ceremonial axes—cutting, piercing, smoothing, scraping, and agricultural implements—the author enters upon a well-considered analysis of the characteristics of the prevailing types, and accompanies his illustrations with descriptions and suggestions indicative of extensive research and accurate archæological knowledge.

In the fourteenth chapter we are made acquainted with the different methods adopted by the Southern Indians for the capture of fish. Grooved, notched, and perforated net-sinkers and plummets are figured. The *chung-kee game*—that famous game of the North American Indians, to which they were so passionately addicted that, when all private property had been gambled away, the desperate players hazarded even their personal liberty upon the final throw—is next considered; and, in this connection, numerous discoidal stones are shown. The limits of this review do not permit us to dwell upon the use of stone tubes in connection with the arts of the medicine-man and the conjurer, as explained by the author, or to enumerate *seriatim* the matters treated of in this entertaining and instructive volume. We commend, as worthy of careful study, the chapters upon pipes (which are considered under the three classes of idol-pipes, calumets, and common pipes), on idols and image-worship, and upon pottery. The Etowah idol, figured at page 432, is perhaps the most notable ancient stone image which has yet been found in association with Indian relics north and east of Mexico. Much historical information has been collected concerning the primitive uses of tobacco and the office of the peace-pipe. In plate XXIII the typical forms

of the calumets and bird-shaped pipes are given. The manufacture of ancient pottery is fully considered; and, in the accompanying plates, the prevailing forms of *terra-cotta* vessels, and the different styles of ornamentation, are beautifully portrayed. The use of pearls as ornaments is made the subject of an independent chapter. It is curious to observe what an important part these little glistening beads played among the ornament-loving peoples of this semi-tropical region. The work concludes with an examination of the primitive employment of shells as ornaments, implements, and as a recognized medium of exchange.

It will be observed that nearly every chapter in this work forms an independent essay, complete in itself, and elaborate of its kind. The originality of the work, both as regards its general plan and the manner of its execution, will be at once remarked. The freshness and vigor of the illustrations are admirable. The typical objects represented have never been figured before, the originals, or nearly all of them, forming part of the author's collection, and most of them having been obtained by him *in situ*. Accurate pen-drawings were first made under his personal supervision and then these were reproduced by the photo-lithographic process—all errors of transfer by an engraver being thus avoided. As a necessary consequence, these illustrations are unusually correct. They possess an individuality which is very attractive. In grouping the objects selected for illustration, marked taste has been displayed. The plan of the work we regard as natural and judicious. In that portion of North America constituting the field of these archæological researches we have only a stone age. Here and there copper implements and ornaments appear, but that material in its manufacture was regarded and treated by the primitive workmen not as a metal capable of being moulded under the influence of heat, but simply as a malleable stone. Chipped and ground stone implements are found in juxtaposition; and, in their uses, are seemingly of equal antiquity. Any attempt, therefore, in the present state of the inquiry, to pursue the classifications usually adopted by European archæologists appeared both unnecessary and improper. Realizing this fact, the author has grouped and described the antiquities of the Southern Indians principally with respect to their uses. Monuments, implements, manufactures, and ornaments, are invested with such explanations as are suggested by the early narratives, by peculiar characteristics, by intelligent comparison, and by the special circumstances under which they were found. The classification adopted has been, in many instances, general, and the author has sought to avoid an error into which writers on kindred subjects are prone to fall, namely, a too rigid classification, and an attempt to refer each relic to some definite use. So uncertain is the boundary line which separates well-recognized types; so varied are the modifications of established forms; so great was the poverty of the manufacturers; and so various the purposes to which the same rude tool may have been applied in conducting early mechanical operations, that the candid observer may often confess himself at a loss to determine the positive object for which a given specimen may have been intended.

In his concluding observations the author says: "Upon a careful comparison of the antiquities of the Southern nations with those of the Northern tribes, we think a greater variety and excellence of manufacture, a more diversified expression of fancy in ornamentation, a more careful selection of beautiful material, a superior delicacy and finish in the fabrication of implements, both chipped and polished, a more pronounced exhibition of combined labor in the erection of tumuli, a more despotic form of government, a greater permanency of seats, a more liberal expenditure of care and attention in the cultivation of the soil, a more decided system of worship, and a more dignified observance of the significant festivals and funeral-customs, may fairly be claimed for the former. We are acquainted with no region north and east of the Rio Grande in which the earliest exhibitions of skill and taste in the manufacture of implements and ornaments of stone, shell, and bone, are more varied and attractive, where pipe-making claimed such special attention, and where the antique pottery is indicative of such diversity of form and ornamentation, and possessed of such homogeneousness of composition and durability."

WORKSHOP APPLIANCES; including Descriptions of the Gauging and Measuring Instruments, the Hand Cutting-tools, Lathes, Drilling, Planing, and other Machine-tools used by Engineers. By C. P. B. SHELLEY, Civil Engineer. 209 Illustrations, 312 pages. Price, $1.50. D. Appleton & Co.

THIS is a hand-book of tools and their uses, compendious in form, and copiously illustrated, which will be of great value to young artisans and mechanics, whether working in wood or metal. There is no end to machines for reshaping the materials of Nature; and inventors are constantly adding to them; but the fundamental tools for producing mechanical effects, with their resources of variation, fall into a few classes, and their modes of action are capable of explanation within a narrow space. It is the variation and recombination of comparatively a few implements that are constantly coming before us in the form of complex and obscurely-acting contrivances. Two objects are to be gained by the use of tools: 1. The production of given mechanical effects; and, 2. Accuracy in the processes. Both of these objects are now attained by mechanics with a remarkable degree of perfection. Mr. Shelley describes these in clear and simple language, which, with his excellent illustrations, makes the subject quite intelligible to ordinary readers. Besides its value as a practical hand-book to the working mechanic, this little volume will have great interest for those who wish to understand how the wonders of modern construction are executed.

MISCELLANY.

Yosemite Valley of Glacial Origin.—In the summer of 1872, Prof. Joseph Le Conte, of the University of California, with several students of the institution, visited the Yosemite and the mountains contiguous, and carefully examined the results of the glacial action which were everywhere apparent. His conclusions were stated in an able paper, published in the *American Journal of Science* for May. The Yosemite Valley, he thinks, was once filled to the brim with a great glacier. In this he differs from Prof. Whitney, who in his guide-book expresses the opinion that there is no evidence that such a glacier existed.

Prof. Le Conte observes that glaciated forms are unmistakably observable at many points on the walls of the valley, and in some places even to the brim. In the contour of the walls of the valley, their rounded form, where the rock is hard, standing unbroken and without *débris* at the base, he finds proofs of glacial erosion. On the north side of the valley, every projecting shoulder is thus rounded, and in some cases the smoothness is so complete, even at a considerable height, that the rocks glisten in the sunshine. Where the rocks are soft, and on the southern side of the valley, which is in shadow, frost and other agencies have done their work of disintegration. The surfaces are broken, and the *débris* lies at the base.

The bed-rock of the valley is covered with mounds of bowlders and sand, which are terminal moraines of glaciers, and by *stratified lake-deposits*, the lakes having been formed by the glacial mounds obstructing the flow of waters.

But it was from the higher elevations that the wonderful features of the glacial erosion were most distinctly observed. "From the edge of the rim of Little Yosemite," says the author, "we had a magnificent bird's-eye view of the wonderful dome-like form of nearly all the prominent points about this valley, and their striking resemblance to glaciated forms cannot be overlooked. The whole surface of the country is *moutonné* on a huge scale. If so, then the greater domes about the Yosemite have been formed in a similar manner. If so, then the whole surface of this region, with its greater and smaller domes, has been moulded beneath a universal ice-sheet, which moved on with steady current, careless of domes."

This great ice-sheet preceded the separate glaciers which completed the erosion of the valleys of which Yosemite is one, and the scattered snow-fields which were discovered by Mr. Muir, of the expedition, are feeble remains of the old glaciers. In the opinion of Prof. Whitney, the Yosemite was formed by a sudden engulfment of a portion of the sierras, but Prof. Le Conte observes that Yosemite is not unique in

form, and probably not in origin. There are many Yosemites. Many of the great glacial valleys become deep, narrow cañons, with precipitous walls near the junction of the granites with the slates. This is the position of Yosemite. It occurs in the valley of the American River and the valley of Hetch Hetchy, which, says the author, almost rivals the Yosemite in grandeur, and, in his opinion, all these deep, perpendicular slots have been sawed out by the action of glaciers, the verticality of the walls having been determined by the perpendicular cleavage of the rocks.

Origin of the Potato-Disease.—Messrs. T. & E. Brice, of Plymtree, England, claim to have discovered the cause of the potato and the foot and mouth diseases, which they assert to be nothing else but the employment of chemical manures. It is remarkable, say they, that both of these diseases made their appearance about the same period. It is some 250 years since the potato was introduced into Britain, and there is no record that the disease ever existed until the year 1845, when, subsequently to a continued rain for some days together, the potato was found to be diseased generally throughout the kingdom. Previous to that time the chemical manures had been introduced, and they were used in great abundance the same season that the potato-disease first appeared. Messrs. Brice were then of opinion that the manure was the cause, and, having since investigated its principles and action, they find that it contains a very active poison—sulphuric acid: "Its particles readily attract the particles of water, producing fermentation, and sometimes causing putrefaction of the compound they adhere to. If the chemical manures are distributed over the land in a dry season, and there is not enough rain to cause fermentation, the sulphuric acid remains fixed on the earth; if it is applied in a wet season, the rain causes fermentation; the effluvium ascends in the atmosphere, and, mixing with the vapors, helps to constitute clouds, when there is a return in poisoned rain and dew on the potatoes, and other bodies as well. Putrefaction of the potato is the consequence, and it has a very offensive smell." The authors have made some experiments with a mixture of water and sulphuric acid. Fermentation and poisoning of the water were the result, and an application of the mixture to the potato caused disease.

But the question naturally arises, Why should the sulphuric acid cause disease only in the potato and not in other plants? and on this point the Messrs. Brice leave us in the dark. Here we may mention another theory which has been proposed to account for this potato-blight. It has been observed that the electrical state of the atmosphere has something to do with the matter, and in Ireland the potato-crop is described as wearing a blighted appearance after a protracted thunder-storm. The theory is, that the electrical condition of the atmosphere causes the conversion of the starch into dextrine, sugar, etc., and the tuber then melts away. But again we ask, Why did not the same causes produce the same effects previous to 1845?

As regards the foot and mouth disease, the cattle and other animals travel and browse where the poison has fallen, and it is taken in with their food. The active particles adhere to their feet, lips, and mouth, destroying the scarf-skin and mucous membrane of the mouth and throat. The symptoms are such as might be produced by sulphuric and other corrosive acids.

A Substitute for Parchment.—Parchment-paper has several properties in common with animal membrane. It is obtained by the action of sulphuric acid or chloride-of-zinc solution on unsized paper. When sulphuric acid is employed, the best solution is one kilogramme (2.20485 pounds) English concentrated sulphuric acid to 125 grammes (about 4.4 ounces) of water. The paper is dipped into the acid so as to moisten both sides uniformly. The length of time it is to remain in the bath depends on its own thickness and density. The minimum time for the ordinary unsized paper of commerce is 5 seconds, the maximum 20. When the acid has acted a sufficient length of time, the paper is first dipped in cold water, then in dilute ammonia, again in water, to remove the acid, and finally it

is dried. When it is left to itself to dry, it becomes shriveled, and has a bad appearance. To guard against this, the following process is adopted: An endless strip of paper is passed by machinery first through a vat of sulphuric acid, and then through water, ammonia, and water again; next a cloth-covered roller deprives it of a portion of the water, and finally it is pressed and smoothed out by means of polished heated cylinders.

When properly manufactured, parchment-paper has the same color and translucency as animal parchment, its structure having undergone a change from fibrous to corneous. In point of cohesion and hygroscopicity, it is very much like common parchment. When dipped in water, it becomes soft and flaccid. It is impermeable to liquids, except by dialysis. These qualities render parchment-paper specially suitable for diplomas, important papers, and in general for documents which it is desirable to preserve. As compared with ordinary parchment, this paper possesses the advantage that it is very little liable to be attacked by insects. Then, too, the characters inscribed on it cannot be effaced without difficulty, and, when effaced, cannot be replaced by others—a perfect guarantee against all kinds of falsification. By reason of its firmness and durability, it is specially suited for plans and drawings, particularly architectural drawings, which are much exposed to moisture. Further, it might be used for covering books; or books, maps, etc., for use in schools, could be printed on it, and would be very durable. In place of animal membrane, it is well suited for covering jars of fruit, extracts, etc., as also for connecting the parts of distilling and other apparatus. It furnishes excellent casings for sausages. In surgery it is employed instead of linen, oiled cloth, and gutta-percha, for dressing wounds.

Improvements in Street-Sprinkling.—An improved method of sprinkling streets has been patented in England, by means of which almost five-sixths of the expense of watering may be saved. It appears that the cost for labor in watering the streets of London averages about $675,000 per annum, the cost of water being additional; and it is contended that this work can be done in a far more effectual and advantageous manner, by a system of permanent pipes, for an expenditure of less than $15,000 per annum, while the interest upon the plant necessary for the purpose would not exceed $100,000. An experiment made in Hyde Park warrants the conclusion that, with the permanent system referred to, the services of one man would be amply sufficient for laying the dust over the whole of the drives and rides in that park—a task which at present engages twenty men, with as many horses and carts. This area may be taken as a seventy-fifth part of the total road-way in London to be watered; and hence we may conclude that about seventy-five men, without either horses or carts, could water the whole metropolis at the cost for labor above stated. The city government of London is giving the matter serious consideration; and, if water is to continue in use for the purpose of laying dust on thoroughfares, the plan will doubtless be generally adopted on being proved practicable. It is to be hoped, however, that before long deliquescent salts will be employed for this purpose rather than water. The use of water in summer hastens the decay of organic matter, and thus is objectionable from a sanitary point of view. Deliquescent salts will not alone lay the dust, but will also disinfect the streets by checking decomposition.

French Association for the Advancement of Science.—The French Association met at Lyons, on August 21st, the opening address being made by the president, Quatrefages. He traced the history of scientific progress during the past hundred years, and advocated the claims of science as an important branch of general education. The reports of the secretary and treasurer show that the Association is in a flourishing state, and that it has already, in its second year, commenced to give material encouragement to original investigators of science. The most notable of the papers read in the general meetings were the following: Dr. H. Blanc, Surgeon-Major of the British Army, on "The Means of guarding against Cholera: an Essay based on Practical Knowledge of the Causes and Mode of Propaga-

tion of that Disease;" Fernand Papillon, on "The Relations between Science and Metaphysics;" the Abbé Ducrost, on "The Prehistoric Station of Solutré;" and Dr. Bertillon on "The Population of France."

One of the sections of the French Association is devoted to the medical sciences. In this department, the most remarkable papers were those of M. Ollier, on "The Surgical Means of favoring the Growth of the Bones in Man;" M. Chauveau, on "The Transmission of Tuberculosis through the Digestive Organs;" M. J. Gayet, on "The Regeneration of the Crystalline Lens;" and M. Diday, on "A Physiological Theory of the Passion of Love."

In anthropology, we may mention M. Lagneau's "Ethnological Researches on the Basin of the Saone and Other Affluents of the Rhone;" M. Chauvet's "Observations on the Bone-Caves of Charente," Gabriel Mortillet and Abel Hovelacque on "The Precursor of Man in the Tertiary Period."

The chemical section presents matter of special interest only for chemists. In that of botany, M. Merget read a paper on "The *rôle* of the Stomata in the Exchange of Gases between the Plant and the Atmosphere."

The Cryptograph.—A very ingenious instrument, the cryptograph, was recently described by its inventor, Pelegrin, in a note communicated to the French Academy of Sciences. The cryptograph is a contrivance intended for noting down on the spot and converting into mathematical expressions, so that they may be sent directly and secretly by telegraph, the polar coördinates of the points which determine a given figure. By means of this instrument, one may—at New York, for instance—trace out figures seen and noted down by a correspondent at any point in telegraphic communication with him. The cryptograph consists of a graduated arc of a circle, and an alidade, or index, also graduated and movable over the entire arc. The alidade has attached to it a small, thin plate of mica, which may slide up and down its entire length. On the mica is a black point, and this, it is plain, may occupy every possible position within the arc. A sight is fixed in front of the instrument. In order, now, to note down the outlines of a given figure, the observer places his eye at the sight, and brings the black speck on the mica over all the chief points, and marks their polar coördinates, as shown by the positions of the alidade and the sliding-point. These numbers may then be transmitted by telegraph anywhere. With the assistance of another cryptograph, in which the mica is replaced by a style or pen, the points noted by the first instrument are at once found and copied on paper.

Localization of the Faculty of Speech.—In a recent memoir on the localization of the faculty of speech in the anterior lobes of the brain, the eminent physiologist Bouillaud communicates to the French Academy of Sciences the results of his protracted researches on that subject. Some of the cases cited by him in the course of the memoir are extremely curious. In some instances, says he, the inability to speak is restricted to a certain class of words—certain proper names, for instance; in others, it extends to all past events; in others, again, only prominent circumstances are involved; and so on. Cuvier tells of a man who had lost the recollection of all *nouns-substantive*, and who would construct his phrases perfectly and regularly, the places of the nouns being always left vacant. Some years ago, M. Bouillaud visited a patient whose vocabulary did not contain a single *verb*, but who, notwithstanding, talked with remarkable volubility: his language was, of course, perfectly unintelligible. Others are unable, of their own accord, to write some particular word—*house*, for instance—though they can copy it when it is placed before them. A lady, forty-three years of age, was suddenly deprived of the power of speech, and entered the Cochin Hospital; she heard and understood perfectly every thing that was said to her, but could not speak. She could express herself in writing, however, and thus it was learned that she suffered pain in the forehead. From these cases, it follows that aphasia is produced by an incapacity to execute the coördinate movements requisite for pronunciation, and that it has nothing to do with loss of memory as to the meaning of words.

According to M. Bouillaud, these phenomena are produced by lesions of the an-

terior cerebral lobes. He claims that his theory is confirmed by the results of several autopsies, and asserts that, wherever he has had an opportunity to examine the brain of patients affected in this way, he always found the anterior lobes softened, inflamed, and more or less profoundly disorganized. These views gave rise to a warm discussion when they were first published to the Academy, and Flourens contributed an important memoir on the subject, in which he took the ground that while the cerebral lobes possess the faculties of will and perception, they do not coördinate movements, the latter function appertaining, according to him, to the cerebellum.

M. Bouillaud sums up as follows the conclusions to which he has been led in the course of his studies: 1. All lesions of the faculty of speech have their origin in affections of the frontal lobes. In some instances, this lesion to the faculty of speech is owing to the fact that the coördinated movements requisite for *the pronunciation of words* cannot be executed. Therefore, there exists in these anterior lobes a coördinating centre for this description of voluntary movements. In other instances, lesions of the faculty of speech have a bearing on the *words* themselves, and not on the act of *pronouncing* them. Therefore, there exists in the same lobes another centre, without the coöperation of which speech is impossible.

2. When either or both of these conditions exist, the faculty of speech may be injured or utterly lost, while all the other special intellectual faculties remain intact, and *vice versa*.

The Rebuilding of Antioch.—In the rebuilding of the city of Antioch, destroyed by earthquake last year, the chief engineer of the province of Aleppo, Mr. Haddan, an Englishman, did his best to induce the people to profit by the experience of the past, and to construct their houses and lay out their streets in such a manner that the recurrence of earthquake might not again prove so destructive. But immobility is the law of the East, and the people will not quit the ancient paths. It is a significant fact, says the *Builder*, that many of the victims on the occasion of the last earthquake might have escaped, if the houses had been built with lime or bound with wood, and if the streets had not been so narrow that the rows of falling buildings met as they crumbled down, to form one destructive heap over the crowds of people. Mr. Haddan proposed that skeleton houses should be erected with timber battens, well tied together with iron bands, on which overhanging roofs would rest. Stone-walls, cemented with lime, were then to be run up around the wooden frames, in order to afford protection from sun and rain. A shock of earthquake (which is a matter of frequent occurrence at Antioch), how formidable soever it might be, could then do no more than throw the stone-walls outward, while none of the falling stones could injure those in the houses. The new plan of the town, by straightening and widening the labyrinth of tortuous lanes which previously existed, would save the inhabitants from much of the danger after escaping from their houses. But, as has been already said, these suggestions have been disregarded, and the town is beginning to rise again on its old foundations, built with mud instead of lime, and likely to destroy its future population in even greater proportion than it did last year, for increased poverty makes the new houses weaker than even the old ones were.

Intelligence of the Toad.—At the recent meeting of the American Association for the Advancement of Science, held at Portland, Mr. Thomas Hill read a note on the intelligence of toads, giving, among other interesting examples of their sagacity, a description of the means by which the creature contrives to force down inconvenient forms of food. "When our toad," says Mr. Hill, "gets into his mouth part of an insect too large for his tongue to thrust down his throat (and I have known of their attempting a wounded humming-bird), he resorts to the nearest stone," and uses it as a *pièce de résistance* in a very literal sense. This can be observed at any time, continues the author, by tying a locust's hind-legs together, and throwing it before a small toad.

On one occasion Mr. Hill gave a small locust to a little toad in its second summer. At once the locust's head was down the creature's throat, the hinder parts protrud-

ing. The toad then sought for a stone or clod; but, as none was to be found, he lowered his head and crept along, pushing the locust against the ground. But the ground was too smooth (a rolled path) and the angle at which the locust lay to the ground too small, and thus no progress was made. "To increase the angle, he straightened up his hind-legs, but in vain. At length he threw up his hind-quarters, and actually stood on his head, or rather on the locust sticking out of his mouth, and, after repeating this once or twice, succeeded in getting himself outside his dinner."

On another occasion the author saw an American toad disposing of an earthworm in the following way. The worm was so long that it had to be swallowed by sections. But, while one end was in the toad's stomach, the other end was coiled about his head. "He waited until the worm's writhings gave him a chance, and swallowed half an inch; then, taking a nip with his jaws, waited for a chance to draw in another half-inch. But there were so many half-inches to dispose of that at length his jaws grew tired, lost their firmness of grip, and the worm crawled out five-eighths of an inch between each half-inch swallowing. The toad, perceiving this, brought his right hand to his jaws, grasping his abdomen with his foot, and, by a little effort getting hold of the worm in his stomach from the outside, he thus, by his foot, held fast to what he had gained by each swallow, and presently succeeded in getting the worm entirely down."

The Sun's Envelope.—Prof. Charles A. Young's paper, read at the American Association, on a liquid solar crust, led to a very animated discussion. The author is inclined to hold, with Faye, Secchi, and others, that the sun is mainly gaseous. At the same time, the eruptions which are continually occurring on its surface almost compel the supposition that there is a crust of some kind which retains the imprisoned gases, and through which they force their way in jets with great violence. According to the author, this crust may consist of a more or less continuous sheet of descending rain—that is, a downfall of the condensed vapors of those materials which we know from the spectroscope exist in the sun. The continuous efflux of the solar heat is equivalent to the supply that would be developed by the condensation from steam to water of a layer of about five feet thick over the whole surface of the sun every minute of time. As this tremendous rain descends, the velocity of the falling drops would be retarded by the resistance of the denser gases underneath; the drops would coalesce until a continuous sheet would be formed; and these sheets would unite and form a sort of bottomless ocean resting on the compressed vapors beneath, and pierced by innumerable ascending jets and bubbles. It would have an approximately constant depth, because it would turn to vapor at the bottom as rapidly as it grew at the surface, though probably the thickness of this crust would continually increase at a slow rate, and its whole diameter grow less.

In other words, Dr. Young would regard the sun as an enormous bubble whose walls are steadily thickening, and its diameter ever lessening, in proportion to the loss of heat. The hypothesis offers no peculiar explanation of the sun-spots, but will agree with any of the current explanations of that phenomenon.

NOTES.

Prof. Strong, of the Drew Theological Seminary, Madison, N. J., is organizing an expedition to Egypt and the Holy Land. It will start about Christmas, and will embrace in its *personnel*, engineers, artists, scientists, and a select party of tourists, all under charge of Prof. Strong, assisted by Prof. T. Norman and Mr. George May Powell.

The *Boston Medical and Surgical Journal* reports a case of semi-asphyxiation from the inhalation of coal-gas, which was very successfully treated by the administration of oxygen. Four men sleeping in one room had inhaled coal-gas. Of these one died before medical aid arrived; the other three were taken to the hospital. Here fresh air and stimulants were resorted to, but the most marked effects followed the administration of oxygen gas. The inhalation of this agent was followed by an almost instantaneous improvement in the condition of the patients. It was found that the supply of oxygen had to be kept up for some time after the appearance of improved respiration, for, when the administration

of the gas was discontinued, a relapse occurred. Soon, however, the improvement became permanent, and the patients were discharged well.

A WRITER in a French scientific periodical states that by feeding silk-worms on vine-leaves he has obtained cocoons of a magnificent red, and, by feeding them on lettuce, others of a very deep emerald green. Another silk-grower has obtained cocoons of a beautiful yellow, others of a fine green, and others again of violet, by feeding the silk-worms on lettuce, or on white nettle. He says that the silk-worms must be fed on mulberry-leaves when young, and supplied with the vine, lettuce, or nettle leaves, during the last twenty days of the larva stage of their life.

A LONDON *Times* correspondent bestows merited praise upon the ventilation of the opera-house at Vienna. On the occasion of the shah's visit, though the house was filled in every part, and though the temperature outside was no less than 85° after sunset, still in the overcrowded house the temperature was just agreeable. The thermometers in the house were under continual inspection, and the temperature regulated according to their indications. What facilitates this regulation is that the gas-lights are under glass globes, which are so arranged that the smoke and heat are carried out by the flue which is above every flame. This arrangement has, besides, the advantage that, even when the house is fully illuminated, the light is never glaring.

CARBOLIC-ACID paper is now much used for packing fresh meats for the purpose of preserving them against spoiling. The paper is prepared by melting five parts of stearine at a gentle heat, and then stirring in thoroughly two parts of carbolic acid, after which five parts of melted paraffine are added. The whole is to be well stirred together till it cools, after which it is melted and applied with a brush to the paper, in quires, in the same way as in preparing the waxed paper so much used in Europe for wrapping various articles.

FROM the official report of Captain G. A. Stover, British political agent at Mandalay, it would appear that Upper Burmah is richer in metals and minerals than any other country in the known world. Gold exists in profusion in the rivers and streams, and in many districts the gold quartz is found in abundance; but the localities are generally malarious, and the mines are not developed. Silver, too, is found in considerable quantities. Rich deposits of copper exist, but are unutilized. Iron abounds in the Shan states and the districts south of Mandalay. Lead is plentiful, and, though tin exists in the Shan states, the mines have never been worked. Coal equal to the best English coal has been discovered in many parts of the interior.

A BERLIN correspondent of the London *Times* gives an account of the extraordinary performance of the new Prussian infantry arm, the Mauser gun. The writer says: "On a distance of 1,500 metres (1,640 yards), out of 480 shots, 399 hits were effected in five targets placed behind each other; and on 1,400 metres (1,564 yards), out of 480 shots, 460 hits are reported. To attack a line in a good position, defended by disciplined soldiers armed with the Mauser, would be the greatest blunder."

O. FEISTMANTEL, of the Austrian Geological Institute, lately read before that body an essay on "The Fossil Plants of Germany and Austria," which will attract the earnest attention of the students of paleontological botany. The author first visited and thoroughly studied all the chief collections of botanical fossils existing in the two countries, and then set about a revision of the species described. He shows that at present the science of phytopaleontology is in a state of confusion, the same species being often described under different names. Different portions of one plant too often figure under sundry names, being sometimes referred to widely diverse genera. Thus we find in some cases the fruit of a plant attributed to one species, while its leaf, trunk, etc., are attributed to others.

THE performance of the "Woolwich infants," or 35-ton English guns, will probably bring about a revolution in the art of naval construction. Experiment has shown that, with the service-charge of powder and the 700-pound shot, these enormous engines can send the projectile through 15 inches of iron at 200 yards, through 14 inches at 300 yards, through 12 inches at 1,700 yards, through 11 inches at 2,600 yards, through 9 inches at 4,000 yards, through 8 inches at 4,500 yards. In each case the usual backing of hard wood has to be added to the thickness of the iron target. Thus, at a range of nearly three miles, a shell one-third of a ton in weight can be made to pierce the sides of some of the heaviest iron-clads, which, a few years ago, were thought to be well protected by 8 or 9 inches of iron.

HIS excellency Chérif Pasha, Minister of Foreign Affairs, has made an order, in behalf of his government, on R. Habersham, Son & Co., Savannah, Georgia, through R. Beardsley, Esq., consul-general of the United States at Alexandria, Egypt, for fifteen tons of Sea-Island cotton-seed for culture in Egypt, under the express direction of the ruler of that country, Ismaïl Pasha.